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CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation-in-part of U.S. Application Serial Number 10/181,876, filed October 10, 2002, entitled "SPRAY DISPENSER", the contents of which are incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to the field of spray dispensers.

BACKGROUND OF THE INVENTION

[0003] Certain products such as insecticides and air fresheners are commonly supplied in pressurized containers. The contents of the container are usually dispensed to the atmosphere by pressing down on a valve at the top of the container, as seen for example in U.S. Patent No. 1,800,156. The contents of the container are consequently emitted through a channel in the valve.

[0004] In many cases it is desired that the contents of the container be automatically dispensed periodically. Many automatic dispensers are known in the art, such as U.S. Patent No. 6,517,009 of the present inventor, the disclosure of which is incorporated herein by reference. U.S. Patent No. 6,517,009 discloses apparatus and method for automatically spraying fluid material in response to a signal from a sensor. The sensor senses the concentration of the fluid material within gas filled surroundings and generates signals responsive to the concentration of the fluid material.

[0005] A type of automatic dispenser includes dispensers with mechanical means, such as an arm or cam, which periodically presses the valve of the container. Such dispensers are described, for example, in U.S. Pat. Nos. 3,018,056; 3,543,122; 3,739,944; 3,768,732; 4,184,612; and 5,038,972. However, these dispensers cannot

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accurately control the output of the container, since the valve and the contact of the dispenser with the valve are not accurately controlled by the dispenser. Furthermore, these dispensers are generally not portable and are fit for use only with containers of a specific size. The dispensers may be costly and require substantial electrical power and frequent reloading of batteries. The valves are also susceptible to failure because of valve sticking, resulting in loss of the requisite snap action desired for spraying contents from a container or in complete discharge of the contents of the container within a short period.

[0006] A further type of automatic dispenser employs a solenoid, which is periodically energized in order to emit a burst of the contents of the container. Such dispensers are described, for example, in U.S. Pat. Nos. 3,187,949; 3,351,240; 4,415,797; and 6,216,925 and U.K. Pat. No. 2,488,888. These dispensers are dependent on gravity and/or the fluid pressure in the container for successful operation. These dispensers are complex, costly, and require substantial electrical power.

[0007] An additional type of automatic dispensers are described, for example, in U.S. Pat. Nos. 2,719,432; 3,477,613; 3,542,248, 3,589,562; 3,658,209; 3,722,749; 3,788,550; 4,077,542; 4,469,255; 5,025,962 5,364,028, 5,447,273, and 6,612,464. In this type of automatic dispenser, the pneumatic pressure of the container is used to operate a timing device causing the contents of the container to be periodically dispensed. However, the ability to control the dispensation intervals is complicated and limited due to the pneumatic characteristic of the timing device or the need for the user to periodically turn a flow control valve. Complex accumulation chambers may add to the manufacturing cost of the dispensers. Spring-biased diaphragms employed in the pneumatic pressure operated automatic dispenser are susceptible to failure due to clogging or leaks. The amount and timing of sprays is hard to control since repeated spray discharges reduce the pressure in a typical container over time, for example from 6 atmospheres to less than 2 atmospheres. The pressure in the container may be lowered in cooler ambient surroundings, contributing to unreliable and non-uniform spraying.

[0008] Another type of automatic dispenser is described in U.S. Patent No. 6,540,155 of the present inventor, the disclosure of which is incorporated herein by reference. This type of automatic spray dispenser allows accurate control of the amount

of discharged material, and allows flexibility in setting the frequency of dispensation. This is preferably accomplished by means of a processor. The dispenser has an open state in which fluid is discharged from a can or container, and a closed state in which the fluid is not emitted. A motor is provided which changes the state of the dispenser between the open and closed states. This is preferably accomplished by means of a flexible lever which is coupled to a threaded shaft which is attached to the motor. The lever is normally in a closed state. The motor rotates the shaft, thereby flexing the lever from the closed state to the open state and vice versa, depending on the direction of rotation.

[0009] A further type of automatic dispenser utilizes a bimetallic spring connected to a valve to control dispensing the contents of a pressurized container. In this dispenser, the bimetallic spring starts, for example, at room temperature, wherein the valve is open for dispensing the contents out of the container. As the contents of the container flow outwards, they thermally contact the bimetallic spring, thereby cooling the spring. Due to its lower temperature, the spring contracts and closes the valve, thereby stopping dispensing the contents from the container. Eventually the bimetallic spring is warmed by the environment back to a temperature sufficient for the spring to re-expand to its original position, thereby opening the valve and once again dispensing a portion of the contents.

[0010] One example of such a bimetallic mechanism includes U.S. Pat. No. 4,361,013. U.S. Pat. No. 4,361,013 does not disclose a spray dispenser, but rather a box for cooling items stored therein. Coil or leaf type bimetallic springs are employed to axially adjust a needle valve in response to temperature changes of the pressurized container and spring caused by escaping vapor.

[0011] A Japanese inventor, Taisho Iketani, patented a number of bimetallic spray devices. U.S. Pat. No. 3,360,165 of Iketani discloses utilizing a screw adjustable bimetallic spring in the path of dispensed content for spray-dispensing content from a container. The bimetallic spring gradually extends until in overcoming the bias of a counter spring it can push a valve past a stopping spring. However, Iketani quickly discovered that such springs are not suitable for spray-dispensing, because they lack the requisite snap action for spraying contents from a container.

[0012] Iketani improved the bimetallic spray dispenser in U.S. Pat. No. 3,419,189, which utilizes a bimetallic disc, shaped like a Belleville washer, clamped around its periphery. However, while the disc does provide the requisite snap action for spraying the contents, nevertheless the bimetallic disc does not operate properly when clamped around its periphery.

[0013] In his next patent, U.S. Pat. No. 3,596,800, Iketani describes the abovementioned problem in col. 3, lines 35 - 43: "The conventional mechanism for supporting a disc-shaped bimetal has been disadvantageous in that slight misalignment of the bimetal or small variation in its size may result in an accidental reversing movement of the bimetal depending upon the clamping forces exerted on its periphery and therefore it is almost impossible to obtain a uniform finished product. Such a problem becomes more serious because the valve mechanism of this type is extremely small." Iketani proposed to solve the problem by clamping not around the entire periphery but rather at a number of discrete points around the periphery. A heat insulating sponge is employed to delay intervals between sprays and battery powered heating is preferably added to ensure operation in cold districts.

[0014] In U.S. Pat. No. 3,685,693, which is a divisional of U.S. Pat. No. 3,596,800, Iketani utilized the same type of discrete clamping. U.S. Pat. No. 3,685,693 discloses that it is impossible to operate the device when the temperature of the bimetallic disc of a heat responsive valve fails to rise above its preselected valve opening temperature. Therefore a manually control heat responsive means is added for spraying without the bimetallic disc.

[0015] In U.S. Pat. No. 3,684,133 Iketani sandwiched the bimetallic disc between portions of a spongy material inwards of the clamped periphery. The purpose of the spongy material is to absorb a volatile liquid, such as methyl alcohol, mixed with the pressurized contents of the spray container, so as to enhance cooling of the bimetallic disc and extend the time period in which the disc is raised or lowered. The device further provides an additional vent that could be enlarged so as to increase the time interval between sprays or could be made smaller so as to shorten the time interval between sprays. However, these features failed to provide reliable snapping action desired for clean and uniform spraying.

[0016] Thus, even with the discrete clamping of the bimetallic disc, these bimetallic spray dispensers have not had reliable performance and apparently have never had any commercial success.

[0017] The prior art dispensers did not provide uniform periodicity of intermittent sprays of fluid without use of electric circuits or processors.

SUMMARY OF THE INVENTION

[0018] The present invention seeks to provide improved spray dispensers.

[0019] It is an object of the present invention to provide an inexpensive, readily available automatic dispenser that can be reliably operated without batteries to provide predetermined dosages of spray at predetermined intervals at a variety of temperatures and settings.

[0020] It is another object of the present invention to provide an automatic spray dispenser with a simple and inexpensive construction that improves upon the prior art devices.

[0021] It is yet another object of the present invention to provide a bimetallic disc, which is freely supported around its perimeter. Thus the bimetallic disc does not have the disadvantage of being sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement. This solves the problem of the prior art found in devices like Iketani's, as described hereinabove.

[0022] It is still another object of the present invention, again in contradistinction to Iketani, to provide a generally rectangular bimetallic element that can either be freely supported, clamped all around its perimeter or clamped only at its short ends. This solves the abovementioned problem of the prior art. Unlike the circular disc, the rectangular bimetallic element is not sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement under the influence of all-around clamping.

[0023] It is a further object of the present invention to allow spray to be automatically dispensed at a predetermined temperature by adjusting a knob.

[0024] It is a still further object of the present invention to employ a temperature dependent biasing force application functionality that will allow spray to be automatically dispensed at a predetermined selected temperature. The predetermined selected temperature is preferably below a shift actuating temperature, of the selected bimetallic disc. Messy sponges and unwanted leaks of fluid material can be avoided.

[0025] It is a yet further object of the present invention to provide a safety valve that prevents undesirable overspraying of the contents of a spray container.

[0026] It is a still further object of the present invention to provide an automatic dispenser that does not require electrical power supply or batteries. Furthermore, the dispenser may provide uniform periodicity of intermittent sprays of fluid without use of electric circuits or processors.

[0027] It is another object of the present invention to provide a dispenser configured to be easily attached and detached from a variety of conventional spray containers of different sizes and configurations and may be transferred from one container to another. Alternatively, a system comprising a dispenser and a spray container may be provided. The dispenser may be attractively constructed in small, unobtrusive dimensions for easy attachment at a cover of a container opening valve of a conventional aerosol container, with or without the use of rings. Alternatively, dispensers with relatively large peripheral diameters may be attached at an upper or lower rim of a conventional aerosol container.

[0028] It is yet another object of the present invention to provide a dispenser, which automatically discharges spray without being dependent on the ambient temperature. Alternatively, a dispenser may allow ambient temperature dependent discharge of spray.

[0029] The dispenser may be provided with a temperature dependent biasing force application functionality including a temperature sensor operative to provide uniform time intervals between sprays notwithstanding temperature changes in ambient environments. The dispenser may also be provided with automatic shut off devices to stop operation of the dispenser when ambient temperatures outside the dispenser are outside a predetermined range of ambient temperatures within the dispenser.

[0030] It is still another object of the present invention to provide a dispenser with a user selection knob so as to enable a user to select an operational parameter of the dispenser, such as the time interval between sprays and the spray initiation temperature.

[0031] It is a further object of the present invention to provide a dispenser which provides reduction in the incidence of liquid droplets in discharged spray.

[0032] It is a yet further object of the present invention to provide a dispenser suitable for use in various environments, such as in a domestic environment, an institutional environment, an agricultural environment and an industrial environment.

[0033] It is a still further object of the present invention to provide a dispenser which provides generally uniform operation of the spray dispenser, such as uniform interval between sprays, spray duration and the quantity of released spray. The dispenser's ability to control for periodicity and uniform duration and dosage of released spray enables the dispenser to provide a chosen container with a selected lifetime of use measurable in a predetermined number of days, weeks or months.

[0034] The dispenser may be used to automatically spray materials that should be released in predetermined quantities at predetermined times.

[0035] It is another object of the present invention to provide a dispenser comprised of a top and a bottom housing portion constructed and configured to be readily attached during manufacturing, such as by a snap-fit attachment or by ultrasonic welding. A bimetallic disc may be placed in a recess between top and bottom housing portions, without being discretely clamped therein, at minimal manufacturing costs.

[0036] It is yet another object of the present invention to provide a dispenser with a flow prevention element operative to be positioned by a user in a position which prevents fluid from reaching a spray release valve of the dispenser and thus prevents fluid from exiting a spray nozzle of the dispenser. The flow prevention element may also be positioned to prevent fluid from reaching the spray release valve during shipment and storage thereby preventing unwanted fluid discharge from the spray dispenser.

[0037] The dispenser may be inexpensively built and attached to a disposable container intended for single use.

[0038] There is thus provided in accordance with a preferred embodiment of the present invention a dispenser for attachment to a container containing a fluid, including an actuator operative to allow the fluid to be released from the container into the dispenser, and an intermittent dispensing assembly that provides an intermittent fluid output, the intermittent dispensing assembly including a temperature responsive shifting element, the temperature responsive shifting element being shiftable in response to temperature changes in the dispenser and being generally freely supported around a perimeter thereof in the dispenser.

[0039] In accordance with another preferred embodiment of the present invention the shifting element includes a bimetallic element having first and second

operative orientations depending on the temperature thereof. Preferably, the bimetallic element comprises a bimetallic disc.

[0040] In accordance with yet another preferred embodiment of the present invention the intermittent dispensing assembly includes a plunger movable in response to shifting of the shifting element. Additionally, the plunger is loosely mounted onto the shifting element. Alternatively, the plunger is welded to the shifting element. Alternatively, the plunger is integrally formed with the shifting element.

[0041] In accordance with still another preferred embodiment of the present invention the plunger is engaged by a biasing spring element. Preferably, the biasing spring element includes a spiral spring. Alternatively, the biasing spring element includes a helical spring. Alternatively, the biasing spring element includes a leaf spring. Alternatively the biasing spring includes a folded over spring.

[0042] In accordance with a further preferred embodiment of the present invention the dispenser also includes a screw biased by a rotatably adjustable knob. Preferably, the rotatably adjustable knob is operative to select a time interval between sprays. Alternatively, the rotatably adjustable knob is operative to select a spray initiation temperature. Additionally, the dispenser also includes a spray release valve.

[0043] In accordance with a yet further preferred embodiment of the present invention the plunger engages a ball of the spray release valve. Alternatively, the plunger includes a pin for engaging the spray release valve. Additionally, the dispenser also includes at least one spray nozzle.

[0044] In accordance with a still further preferred embodiment of the present invention the dispenser includes a plurality of radially distributed inward facing resilient prongs for resiliently engaging the container. Preferably, the prongs are provided with legs for engaging the container so as to prevent removal of the dispenser from the container. Additionally, the prongs engage the container at a location adjacent to a portion of a cover of a container opening valve of the container. Additionally, the location is on an outwardly protruding portion of the cover for engaging inwardly facing legs of the prongs. Preferably, the dispenser engages the container in a ringless engagement.

[0045] In accordance with another preferred embodiment of the present invention the dispenser includes a fastening element resiliently engaging the container.

Preferably, the dispenser is formed with a recess on a bottom portion thereof. Preferably, the recess engages a discharge orifice element of a container opening valve of the container. Additionally, the dispenser also includes a mounting element.

[0046] In accordance with another preferred embodiment of the present invention the dispenser also includes a temperature dependent biasing force application functionality.

[0047] In accordance with yet another preferred embodiment of the present invention the temperature dependent biasing force application functionality includes an ambient temperature sensor responsive to changes in ambient temperature outside the dispenser so as to selectively bias the shifting element. Preferably, the ambient temperature sensor includes a bimetallic coil element. Additionally, the ambient temperature sensor does not communicate with the fluid.

[0048] In accordance with still another preferred embodiment of the present invention the dispenser also includes a rotatable cam fixedly mounted onto a shaft rotatable by the ambient temperature sensor. Preferably, a rotatable cam applies a biasing force to a biasing spring element. Additionally, the biasing force increases as ambient temperature outside the dispenser is lowered and decreases as the temperature rises.

[0049] In accordance with a further preferred embodiment of the present invention the biasing force is minimized when the temperature is below a minimum operation temperature. Additionally, the biasing force is minimized when the temperature is above a maximum operation temperature. Preferably, the temperature above the maximum operation temperature is below a shift actuating temperature of the shifting element.

[0050] In accordance with a yet further preferred embodiment of the present invention the rotatable cam includes a cam thickness such that the rotatable cam applies a suitable biasing force to the shifting element via the biasing spring element so as to dispense the fluid substantially within a uniform selected time interval between sprays. Preferably, the rotatable cam includes a cam thickness sufficiently small such that the rotatable cam provides a sufficiently low biasing force to the shifting element so as to minimize shifting of the shifting element.

[0051] In accordance with a still further preferred embodiment of the present invention the shifting element is loosely mounted within the dispenser. Preferably, the shifting element is seated in an annular recess in the dispenser. Additionally, the dispenser includes a volume surrounding the shifting element and being formed with inclined walls on a bottom portion thereof.

[0052] In accordance with another preferred embodiment of the present invention at least part of the fluid passes around the shifting element via passageways formed in the dispenser. Preferably, a volume overlying the shifting element allows for enhanced dissipation of the fluid and thereby reduces incidence of liquid droplets in the fluid exiting the dispenser. Additionally, the dispenser defines an internal volume so as to relatively thermally isolate the intermittent dispensing assembly from the ambient outside the dispenser.

[0053] In accordance with yet another preferred embodiment of the present invention the fluid is dispensed as an aerosol. Preferably, the fluid is dispensed as a dissipated aerosol. Additionally, the fluid includes a deodorant. Alternatively, the fluid includes an insecticide. Preferably, the dispenser also includes a flow prevention element.

[0054] There is thus provided in accordance with another preferred embodiment of the present invention a fluid dispensing system including a container containing a fluid, and a dispenser for receiving the fluid via an opening in the container and including an intermittent dispensing assembly that provides an intermittent fluid output, the intermittent dispensing assembly including a temperature responsive shifting element, the temperature responsive shifting element being shiftable in response to temperature changes in the dispenser and being generally freely supported around a perimeter thereof in the dispenser.

[0055] There is thus provided in accordance with yet another preferred embodiment of the present invention a dispenser for attachment to a container having a container opening valve and containing a fluid, including an actuator for keeping the container opening valve in a substantially open position so as to allow the fluid to pass into the dispenser, and an intermittent dispensing valve that provides an intermittent fluid output, the intermittent dispensing valve including a temperature responsive valve control element which is responsive to temperature changes resulting from dispensed

fluid, the temperature responsive valve control element being generally freely supported around a perimeter thereof in the dispenser.

[0056] There is thus provided in accordance with still another preferred embodiment of the present invention a dispenser for resilient attachment to a container containing a fluid for intermittently dispensing the fluid, including prongs for attachment to the container at a location adjacent to a portion of a cover of a container opening valve of the container. Preferably, the attachment is a ringless attachment.

[0057] There is thus provided in accordance with still another preferred embodiment of the present invention a method for dispensing a fluid from a container including attaching a dispenser to the container, the dispenser including an actuator so as to allow the fluid to be released into the dispenser, and automatically intermittently dispensing the fluid from the dispenser using an intermittent dispensing assembly including a temperature responsive shifting element, the temperature responsive shifting element being shiftable in response to temperature changes in the dispenser and being generally freely supported around a perimeter thereof in the dispenser.

[0058] In accordance with another preferred embodiment of the present invention the shifting element has first and second operative orientations depending on the temperature thereof. Preferably, the attaching the dispenser to the container includes engaging the container with a fastening element. Additionally, the attaching the dispenser to the container includes resiliently engaging the container with a plurality of radially distributed inward facing resilient prongs.

[0059] In accordance with yet another preferred embodiment of the present invention the intermittently dispensing includes dispensing the fluid via at least one spray nozzle. Preferably, the method for dispensing a fluid also includes selectively biasing the shifting element by an ambient temperature sensor. Additionally, the intermittently dispensing includes opening a spray release valve of the dispenser so as to dispense the fluid.

[0060] In accordance with still another preferred embodiment of the present invention the intermittently dispensing includes retaining a portion of the fluid, and subsequently releasing the portion of the fluid. Preferably, the intermittently dispensing includes passing at least part of the fluid around the shifting element, via passageways formed in the dispenser. Additionally, the intermittently dispensing includes producing

enhanced dissipation in a relatively large volume overlying the shifting element and reducing incidence of liquid droplets in the fluid exiting the at least one spray nozzle.

[0061] In accordance with a further preferred embodiment of the present invention the intermittently dispensing includes dispensing the fluid substantially within a uniform selected time interval between sprays. Preferably, the intermittently dispensing includes dispensing the fluid substantially at a selected spray initiation temperature. Additionally, the intermittently dispensing includes dispensing the fluid as an aerosol. Preferably, the intermittently dispensing includes dispensing the fluid as a dissipated aerosol.

[0062] In accordance with a yet further preferred embodiment of the present invention the intermittently dispensing includes dispensing a deodorant. Preferably, the intermittently dispensing includes dispensing an insecticide. Additionally, the shifting element shifts to the first operative orientation in response to cooling of the shifting element by dispensed fluid.

[0063] In accordance with a still further preferred embodiment of the present invention the shifting element shifts to the second operative orientation in response to warming of the shifting element by the ambient outside the dispenser. Preferably, the method for dispensing a fluid also includes positioning a flow prevention element of the dispenser to allow the fluid to be released into the dispenser.

[0064] There is thus provided in accordance with a further preferred embodiment of the present invention a method for dispensing a fluid from a container including providing a container with a container opening, attaching a dispenser to the container for receiving the fluid from the container, and automatically intermittently dispensing the fluid from the dispenser using an intermittent dispensing assembly including a temperature responsive shifting element, the temperature responsive shifting element being shiftable in response to temperature changes in the dispenser and being generally freely supported around a perimeter thereof in the dispenser.

[0065] There is thus provided in accordance with a further preferred embodiment of the present invention biasing functionality for a dispenser intermittently dispensing a fluid in response to temperature changes, including a plunger, a temperature responsive shifting element being shiftable in response to temperature changes and mounted on the plunger, and a spring biasing element engaging the plunger

so as to cause the shifting element to shift substantially at a selected temperature. Preferably, the shifting element includes a bimetallic element having first and second operative orientations depending on the temperature thereof. Additionally, the bimetallic element includes a bimetallic disc.

[0066] In accordance with another preferred embodiment of the present invention the plunger is loosely mounted onto the shifting element. Alternatively, the plunger is welded to the shifting element. Additionally or alternatively, the plunger is integrally formed with the shifting element.

[0067] In accordance with yet another preferred embodiment of the present invention the biasing spring element includes a spiral spring. Alternatively, the biasing spring element includes a helical spring. Alternatively, the biasing spring element includes a leaf spring. Alternatively, the biasing spring includes a folded over spring.

[0068] In accordance with still another preferred embodiment of the present invention the biasing functionality also includes a screw biased by a rotatably adjustable knob. Preferably, the biasing spring applies a fixed force to the plunger. Alternatively, the biasing spring applies a variable force to the plunger.

[0069] In accordance with a further preferred embodiment of the present invention the rotatably adjustable knob is operative to select a time interval between sprays. Alternatively, the rotatably adjustable knob is operative to select a spray initiation temperature.

[0070] In accordance with a yet further preferred embodiment of the present invention the biasing functionality also includes temperature dependent biasing force application functionality. Preferably, the temperature dependent biasing force application functionality includes an ambient temperature sensor responsive to changes in ambient temperature outside the dispenser so as to selectively bias the shifting element. Additionally, the ambient temperature sensor includes a bimetallic coil element. Preferably, the ambient temperature sensor does not communicate with the fluid.

[0071] In accordance with a still further preferred embodiment of the present invention biasing functionality also includes a rotatable cam fixedly mounted onto a shaft rotatable by the ambient temperature sensor. Preferably, a rotatable cam applies a biasing force to the biasing spring element. Additionally, the biasing force increases as

ambient temperature outside the dispenser is lowered and decreases as the temperature rises.

[0072] In accordance with another preferred embodiment of the present invention the biasing force is minimized when the temperature is below a minimum operation temperature. Additionally, the biasing force is minimized when the temperature is above a maximum operation temperature. Preferably, the temperature above the maximum operation temperature is below a shift actuating temperature of the shifting element.

[0073] In accordance with yet another preferred embodiment of the present invention the rotatable cam includes a cam thickness such that the rotatable cam applies a suitable biasing force to the shifting element via the biasing spring element so as to dispense the fluid substantially within a uniform selected time interval between sprays. Preferably, the rotatable cam includes a cam thickness sufficiently small such that the rotatable cam provides a sufficiently low biasing force to the shifting element so as to minimize shifting of the shifting element. Additionally, the shifting element is loosely mounted within the dispenser.

BRIEF DESCRIPTION OF THE DRAWINGS

[0074] The present invention will be more fully understood and appreciated from the following description taken in conjunction with the drawings in which:

[0075] Fig. 1 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with a preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0076] Fig. 2 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 1, cut along lines II – II in Fig. 1;

[0077] Figs. 3A & 3B are sectional illustrations of the spray dispenser of Fig. 1, taken along lines III - III in Fig. 1 in two operative orientations;

[0078] Figs. 4A & 4B are sectional illustrations of the spray dispenser of Figs. 3A & 3B, taken along lines IVA - IVA and IVB - IVB respectively, Fig. 4A also including an insert illustrating an enlarged section taken along lines A - A in Fig. 4A;

[0079] Figs. 5A, 5B, 5C & 5D are sectional illustrations of the spray dispenser of Fig. 1, taken along lines V – V in Fig. 1 in four operative orientations;

[0080] Fig. 6 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with another preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0081] Fig. 7 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 6, cut along lines VII – VII in Fig. 6;

[0082] Figs. 8A & 8B are sectional illustrations of the spray dispenser of Fig. 6, taken along lines VIII – VIII in Fig.6 in two operative orientations;

[0083] Figs. 9A & 9B are sectional illustrations of the spray dispenser of Figs. 8A & 8B, taken along lines IXA – IXA and IXB - IXB respectively, Fig. 9A also including an insert illustrating an enlarged section taken along lines A - A in Fig. 9A;

[0084] Figs. 10A & 10B are each a simplified top view illustration of an embodiment of the spray dispenser of Fig. 6;

[0085] Fig. 11 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with yet another preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0086] Fig. 12 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 11, cut along lines XII – XII in Fig. 11;

[0087] Figs. 13A, 13B & 13C are sectional illustrations of the spray dispenser of Fig. 11, taken along lines XIII – XIII in Fig.11 in three operative orientations;

[0088] Figs. 14A & 14B are sectional illustrations of the spray dispenser of Figs. 13B & 13C, taken along lines XIVA – XIVA and XIVB - XIVB respectively, Fig. 14B also including an insert illustrating an enlarged section taken along lines A - A in Fig. 14B;

[0089] Figs. 15A & 15B are each a simplified top view illustration of an embodiment of the spray dispenser of Fig. 11;

[0090] Fig. 16 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with still another preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0091] Fig. 17 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 16, cut along lines XVII – XVII in Fig. 16;

[0092] Figs. 18A, 18B & 18C are sectional illustrations of the spray dispenser of Fig. 16, taken along lines XVIII – XVIII in Fig.16 in three operative orientations;

[0093] Figs. 19A & 19B are sectional illustrations of the spray dispenser of Figs. 18B & 18C, taken along lines XIXA – XIXA and XIXB - XIXB respectively, Fig. 19B also including an insert illustrating an enlarged section taken along lines A - A in Fig. 19B;

[0094] Fig. 20 is a simplified top view illustration of the spray dispenser of Fig. 16;

[0095] Fig. 21 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with a further preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0096] Fig. 22 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 21, cut along lines XXII – XXII in Fig. 21;

[0097] Figs. 23A & 23B are sectional illustrations of the spray dispenser of Fig. 21, taken along lines XXIII – XXIII in Fig. 21 in two operative orientations;

[0098] Figs. 24A & 24B are sectional illustrations of the spray dispenser of Figs. 23A & 23B, taken along lines XXIVA – XXIVA and XXIVB - XXIVB respectively, Fig. 24A also including an insert illustrating an enlarged section taken along lines A - A in Fig. 24A;

[0099] Figs. 25A & 25B are each a simplified top view illustration of an embodiment of the spray dispenser of Fig. 21;

[0100] Fig. 26 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with a yet further preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0101] Fig. 27 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 26, cut along lines XXVII – XXVII in Fig. 26;

[0102] Figs. 28A & 28B are sectional illustrations of the spray dispenser of Fig. 26, taken along lines XXVIII – XXVIII in Fig. 26 in two operative orientations;

[0103] Figs. 29A & 29B are sectional illustrations of the spray dispenser of Figs. 28A & 28B, taken along lines XXIXA – XXIXA and XXIXB - XXIXB respectively, Fig. 29A also including an insert illustrating an enlarged section taken along lines A - A in Fig. 29A;

[0104] Figs. 30A & 30B are each a simplified top view illustration of an embodiment of the spray dispenser of Fig. 26;

[0105] Fig. 31 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with a still further preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0106] Fig. 32 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 31, cut along lines XXXII – XXXII in Fig. 21;

[0107] Figs. 33A & 33B are sectional illustrations of the spray dispenser of Fig. 31, taken along lines XXXIII – XXXIII in Fig. 31 in two operative orientations;

[0108] Figs. 34A & 34B are sectional illustrations of the spray dispenser of Figs. 33A & 33B, taken along lines XXXIVA – XXXIVA and XXXIVB - XXXIVB respectively, Fig. 34A also including an insert illustrating an enlarged section taken along lines A - A in Fig. 34A;

[0109] Fig. 35 is a simplified pictorial illustration of a spray dispenser constructed and operative in accordance with an additional preferred embodiment of the present invention mounted on a conventional pressurized aerosol container;

[0110] Fig. 36 is a simplified cut away pictorial illustration of the spray dispenser of Fig. 35, cut along lines XXXVI– XXXVI in Fig. 35;

[0111] Figs. 37A, 37B & 37C are sectional illustrations of the spray dispenser of Fig. 35, taken along lines XXXVII – XXXVII in Fig. 35 in three operative orientations;

[0112] Figs. 38A & 38B are sectional illustrations of the spray dispenser of Figs. 37B & 37C, taken along lines XXXVIIIA – XXXVIIIA and XXXVIIIB - XXXVIIIB respectively, Fig. 38B also including an insert illustrating an enlarged section taken along lines A - A in Fig. 38B;

[0113] Figs. 39A & 39B are each a simplified top view illustration of an embodiment of the spray dispenser of Fig. 35;

[0114] Figs. 40A and 40B are simplified pictorial illustrations of a spray valve constructed and operative in accordance with a preferred embodiment of the present invention, in respective closed and open configurations, wherein a fluid flows against a lower surface of a deformable element and exits as a fluid spray from a side outlet;

[0115] Figs. 41A and 41B are simplified pictorial illustrations of a spray valve constructed and operative in accordance with another preferred embodiment of the present invention, in respective closed and open configurations, wherein the fluid flows against an upper surface of the deformable element and exits as a fluid spray from a side outlet;

[0116] Figs. 42A and 42B are simplified pictorial illustrations of a spray valve constructed and operative in accordance with yet another preferred embodiment of the present invention, in respective closed and open configurations, wherein the fluid flows against an upper surface of the deformable element and exits as a fluid spray from an upper outlet;

[0117] Figs. 43A and 43B are simplified pictorial illustrations of a spray valve constructed and operative in accordance with another preferred embodiment of the present invention, in respective closed and open configurations, wherein the fluid flows against both lower and upper surfaces of the deformable element and exits as a fluid spray from a side outlet;

[0118] Fig. 44 is a simplified sectional illustration of a safety spray valve constructed and operative in accordance with a preferred embodiment of the present invention;

[0119] Figs. 45A and 45B are simplified sectional and top-view illustrations, respectively, of a spray valve constructed and operative in accordance with still another preferred embodiment of the present invention, which employs a generally rectangular deformable element clamped around its perimeter;

[0120] Figs. 45C and 45D are simplified sectional and top-view illustrations, respectively, of a spray valve constructed and operative in accordance with yet another preferred embodiment of the present invention, which employs a generally rectangular deformable element clamped at its short ends;

[0121] Figs. 45E and 45F are simplified sectional illustrations of the spray valve of Figs. 45C and 45D, respectively during and after the deformable element reversing its position;

[0122] Figs. 46A, 46B and 46C are simplified pictorial illustrations of a spray valve constructed and operative in accordance with still another preferred embodiment of the present invention, in respective full, partially full and nearly empty configurations, wherein contents of a spray container can be sprayed without shaking the container; and

[0123] Fig. 46D is a simplified illustration of the spray valve of Figs. 46A - 46C, with an upper aperture formed in a feed tube, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0124] Reference is now made to Fig. 1, which is a simplified pictorial illustration of a spray dispenser 100 constructed and operative in accordance with a preferred embodiment of the present invention mounted on a container such as a conventional pressurized aerosol container. As seen in Fig. 1, the spray dispenser 100 comprises a housing 101, preferably including a bottom housing portion 102 and a top housing portion 103. Bottom housing portion 102 is preferably configured to define a plurality of radially distributed inward facing resilient prongs 104, which resiliently engage a cover 105 of a container opening valve 106 of a conventional pressurized aerosol container 108.

[0125] Prongs 104 are preferably formed of a resilient material such as a resilient plastic so as to allow spray dispenser 100 to resiliently engage container 108 without use of any other means.

[0126] It is appreciated that spray dispenser 100 may engage conventional pressurized aerosol container 108 on a top portion of conventional pressurized aerosol container 108, as described hereinbelow with reference to Figs. 21 and 26.

[0127] It is noted that pressurized aerosol container 108 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0128] The housing 101 is provided with an ambient temperature sensor 110 and with a spray nozzle 112 of any suitable configuration. The ambient temperature sensor 110 may be mounted within an apertured housing 114. The ambient temperature sensor 110, preferably thermally isolated from the remainder of the interior of the housing 101, may be on top housing portion 103, as seen in Fig. 1, or, alternatively, may be on bottom housing portion 102, or may be in housing 101 and be exposed to the ambient temperatures via one or more ports. Temperature sensor 110 is preferably placed such that it does not communicate with fluid exiting the spray dispenser 100 via spray nozzle 112, nor does it communicate with fluid passing through a spray release valve, described hereinbelow in reference to Fig. 2.

[0129] Reference is now made to Fig. 2, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 100 of Fig. 1. An intermittent dispensing valve comprising a temperature responsive valve opening control element, in the form of a bimetallic disc 120 of any suitable configuration, is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 108.

[0130] Bimetallic disc 120 is constructed of a bimetallic material, i.e., two dissimilar metals welded or otherwise joined together, the two metals having different temperature coefficients of expansion. Due to the different thermal properties of the two metals, bimetallic disc 120 is in a lowered orientation, in the sense shown in Fig. 3A, when in a predetermined lowered orientation shift actuating temperature and reversibly shifts to a raised orientation in the sense shown in Fig. 3B, upon reaching a predetermined raised orientation shift actuating temperature.

[0131] It is appreciated that bimetallic disc 120 may be positioned within spray dispenser 100 in any suitable position, such as the position shown in Figs. 1 – 4B. Alternatively, the bimetallic disc may be positioned to shift laterally or may be positioned at any suitable angle within spray dispenser 100.

[0132] It is noted that a bimetallic disc with a relatively low lowered orientation actuating temperature, will have a longer cooling duration and hence a longer spray duration and will release a greater quantity of spray than a bimetallic disc with a relatively high lowered orientation shift actuating temperature. It is noted that in embodiments which the fluid is discharged by shifting the bimetallic disc to a raised spraying orientation, a bimetallic disc with a relatively high raised orientation actuating temperature, will have a longer cooling duration and hence a longer spray duration and will release a greater quantity of spray than a bimetallic disc with a relatively low raised orientation shift actuating temperature.

[0133] Additional features of the spray dispenser 100 influence the spray duration and quantity of released spray, as described hereinbelow with reference to Figs. 40A and 40B.

[0134] As seen in Fig. 2, the bimetallic disc 120 is mounted within an annular recess 121, which is preferably defined in the spray dispenser 100. The recess 121 is preferably formed with a circumference that is slightly larger than the circumference of

the bimetallic disc 120 and preferably has a height that is slightly larger than the height of the bimetallic disc 120. This is to prevent a clamping force from being applied to the periphery of the bimetallic disc 120 and thereby allow the bimetallic disc 120 to readily assume its operative orientation, as will be described hereinbelow with reference to Figs. 3A and 3B.

[0135] Intermitted actuation of spraying of the contents of the pressurized aerosol container 108 is preferably achieved by a plunger 122, which is mounted onto bimetallic disc 120. The plunger 122 is preferably seated within a slotted ring 123, which overlies an aperture 124 formed in bimetallic disc 120. As seen in Fig. 2, the aperture 124 is preferably formed with a circumference that is slightly larger than the circumference of the plunger 122 so as to prevent a clamping force from being applied to the bimetallic disc 120 by the plunger 122 and thereby allow the bimetallic disc 120 to assume its operative orientation, as will be described hereinbelow with reference to Figs. 3A and 3B. Alternatively, plunger 122 may be integrally formed with or welded to bimetallic disc 120.

[0136] A lower portion 125 of plunger 122 preferably engages a ball 126 of a spray release valve 128 of dispenser 100. Plunger 122 also includes an upper portion 130, which is engaged by a biasing spring element 132. Biasing spring element 132 is in turn biased to a variable degree by a biasing force applied by a rotatable cam 134, which is fixedly mounted onto a shaft 136, which is rotatably mounted in top housing portion 103. Selective biasing of bimetallic disc 120 takes place along an axis 138. It is appreciated that although ball 126 is used in spray release valve 128 any suitable valve control element may be used, such as stopper 1106 of Fig. 44.

[0137] Rotation of the shaft 136, and thus of the cam 134, is responsive to the ambient temperature within apertured housing 114. The temperature sensor 110, here preferably comprised of a bimetallic coil element 140, is mounted at one end thereof to an extreme end 141 of the apertured housing 114 and is fixed at an opposite end thereof to shaft 136. Changes in the ambient temperature cause the bimetallic coil element 140 to rotate about an axis 142, perpendicular to axis 138, and thus cause rotation of shaft 136 about axis 142, thereby producing corresponding rotation of cam 134, which is in contact with biasing spring element 132, and thus providing ambient temperature dependent biasing of the bimetallic disc 120. Alternatively, the temperature sensor 110

may comprise any other suitable element, such as a spiral spring, a helical spring or a leaf spring instead of bimetallic coil element 140.

[0138] This ambient temperature dependent biasing provides ambient temperature independent operation of the spray dispenser 100 so as to provide uniform time interval between sprays notwithstanding changes in the ambient temperature outside the spray dispenser 100. In accordance with a preferred embodiment of the present invention, the cam 134 is configured so that outside of a predetermined range of ambient temperatures, spraying of the contents of the pressurized aerosol container 108 does not take place.

[0139] It is appreciated that the bimetallic coil element 140 may be selectively positioned by a user in a position which will provide operation of the spray dispenser 100 generally in accordance with a user selection, such as within a user selected time interval between sprays. It is appreciated that a knob (not shown) may be added to allow the user to turn the bimetallic coil element 140 to a position which will provide operation of the spray dispenser 100 generally in accordance with the user selection.

[0140] Reference is now made to Figs. 3A & 3B, which are sectional illustrations of the spray dispenser 100 of Fig. 1, taken along lines III - III in Fig. 1 in respective spraying and non-spraying operative orientations and to Figs. 4A and 4B, which are sectional illustrations of the spray dispenser 100 of Figs. 3A & 3B, taken along lines IVA - IVA and IVB - IVB respectively, wherein Fig. 4A also includes an insert which shows an enlarged section taken along lines A - A in Fig. 4A. When the spray dispenser 100 of Figs. 1 - 3B is initially mounted onto the pressurized aerosol container 108, a discharge orifice element 150 of the container opening valve 106 of the pressurized aerosol container 108 is engaged in a recess 152 at the bottom of bottom housing portion 102. A top surface 154 of the discharge orifice element 150 is sealingly engaged by an actuator, which is operative to allow fluid to be released from the interior of the pressurized aerosol container 108 into the spray dispenser 100, via discharge orifice element 150. The actuator pushes top surface 154 towards container opening valve 106, thereby depressing discharge orifice element 150 and thus the container opening valve 106 is maintained in a substantially open position.

[0141] It is appreciated that the actuator may comprise plunger 122 or a pin operative to form an aperture in the conventional pressurized aerosol container 108 and

thereby allowing fluid flow from conventional pressurized aerosol container 108 into spray dispenser 100.

[0142] It is noted that when the ambient temperature outside the spray dispenser 100 remains within the predetermined range of ambient temperatures and the temperature inside the spray dispenser 100 is above a predetermined shift actuating temperature, the bimetallic disc 120 of the spray dispenser 100 is located in a lowered spraying orientation, as shown in Fig. 3A. The aforesaid predetermined shift actuating temperature inside spray dispenser 100 corresponds to a predetermined lowered orientation shift actuating temperature of the bimetallic disc 120. In this lowered spraying orientation the lower portion 125 of plunger 122, which extends below bimetallic disc 120, preferably engages ball 126 of spray release valve 128, forcing it away from its valve seat 157 and thus opening spray release valve 128. Accordingly, release of pressurized fluid, via discharge orifice element 150, produces a flow of fluid past ball 126 and around bottom portion 125 of plunger 122.

[0143] Part of the fluid enters a volume 158 underlying bimetallic disc 120 and exits through spray nozzle 112. It is appreciated that spray release valve 128 may be obviated and plunger 122 may directly engage discharge orifice element 150 so as to allow pressurized fluid to flow from container opening valve 106 into the spray dispenser 100.

[0144] Volume 158 is defined by inclined walls 159 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 112 for release during a subsequent discharge of fluid via spray nozzle 112 to the ambient.

[0145] As seen particularly clearly in the insert in Fig. 4A, part of the fluid passes around bimetallic disc 120, via passageways 160 formed in housing 101, and expands in a volume 162 lying above bimetallic disc 120, as shown in Figs. 3A and 3B, permitting vaporization of the fluid within volumes 158 and 162 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 112. Evaporation of the fluid released from pressurized aerosol container 108 (Figs. 1 - 3B) both above and below the bimetallic disc 120 provides cooling of both top and bottom surfaces of bimetallic disc 120 to the raised orientation shift actuating temperature, causing the bimetallic disc 120 to shift its orientation from a lowered spraying orientation, as shown in Fig. 3A, to a raised non-spraying orientation, as shown in Fig. 3B. In this non-

spraying orientation the lower portion 125 of the plunger 122 does not dislodge the ball 126 from its valve seat 157 in the spray release valve 128, thus preventing outflow of fluid therepast. The fluid pressure of the aerosol in pressurized aerosol container 108 maintains the ball 126 in seated, sealing engagement with its valve seat 157, such that spray release valve 128 remains closed.

[0146] It is noted that when plunger 122 does not dislodge the ball 126 from its valve seat 157, the ball 126 provides safety protection if any malfunction occurs. The fluid pressure of the aerosol in pressurized aerosol container 108 forces the ball 126 to be in sealing engagement with its valve seat 157, such that spray release valve 128 remains closed, thereby preventing further spraying of the contents of the pressurized aerosol container 108. Ball 126 can prevent leaking or overspraying due to a variety of malfunctions. Malfunctions can possibly occur, for example, due to knocks or blows to the pressurized aerosol container 108, dropping the container 108, a gas leak, or the fluid inside the container 108 being spent.

[0147] Following termination of fluid flow from pressurized aerosol container 108 past bimetallic disc 120, the ambient temperature in the spray dispenser 100 gradually rises above the aforesaid predetermined shift actuating temperature, and the bimetallic disc 120 is gradually warmed, until, upon passage of a selected time interval between sprays to the lowered orientation shift actuating temperature, the bimetallic disc 120 once again assumes the lowered spraying orientation shown in Figs. 3A and 4A.

[0148] It is appreciated that the selected time interval between sprays is maintained generally uniform irrespective of ambient temperature variations outside the spray dispenser 100 within the range of operation of the spray dispenser 100, by virtue of operation of a temperature dependent biasing force application functionality described hereinbelow with reference to Figs. 5A - 5D. More specifically, the operation of the bimetallic disc 120 between its lowered spraying orientation, as shown in Fig. 3A, and its raised non-spraying orientation, as shown in Fig. 3B, is naturally, in the absence of the application of external biasing forces, dependent on the ambient temperature outside the spray dispenser 100, which determines the rate at which the temperature of the bimetallic disc 120 changes. In order to reduce the dependency of the operation of the bimetallic disc 120 on the ambient temperature outside the spray

dispenser 100, the temperature dependent biasing force application functionality described hereinbelow with reference to Figs. 5A - 5D is provided so as to apply a variable biasing force to the plunger 122 urging the bimetallic disc 120 to assume its lowered spraying orientation, which assumption would, in the absence of the application of the biasing force, have been delayed.

[0149] This biasing force increases in inverse proportion to a decrease in ambient temperature outside the spray dispenser 100, within a range of temperatures of the spray dispenser 100. Thus, when the ambient temperature outside the spray dispenser 100 decreases in a way which would otherwise slow the warming of the bimetallic disc 120 and correspondingly delay its assumption of the lowered spraying orientation of Fig. 3A the temperature dependent biasing force application functionality provides a correspondingly increased biasing force, to the bimetallic disc 120, thus eliminating the delay that would otherwise have been caused by the slowed warming, as described hereinbelow with reference to Figs. 5A – 5C.

[0150] It is noted that a relatively large volume 162 is shown in Figs. 3A and 3B. This relatively large volume 162 allows for relatively long residence of the fluid within the spray dispenser 100, producing enhanced vaporization of the fluid thereby reducing the incidence of liquid droplets and resulting in a dissipated aerosol spray exiting spray nozzle 112. Should a smaller volume be provided, as shown in Figs. 16 – 20, a relatively greater incidence of liquid droplets in the aerosol spray can be expected to occur.

[0151] Reference is now made to Figs. 5A, 5B, 5C & 5D, which are sectional illustrations of the spray dispenser 100 of Fig. 1, taken along lines V – V in Fig. 1 in four non-spraying operative orientations. Figs. 5A – 5D illustrate the temperature dependent biasing force application functionality providing automatic adjustment of the spray dispenser 100 in response to ambient temperature outside the spray dispenser 100, to preferably provide operation of the spray dispenser 100 with reduced dependence on the ambient temperature outside the spray dispenser 100. This ambient temperature independent operation preferably provides uniform operation of the spray dispenser 100, such as uniform intervals between sprays notwithstanding changes in the ambient temperate outside the spray dispenser 100. As seen in Fig. 5A, the cam 134 is at a position corresponding to a temperature at the highest range of the predetermined range

of ambient temperatures. Here a relatively small cam thickness is provided between axis 142 and a cam contact location 170 on biasing spring element 132, applying a low biasing force along axis 138 to bimetallic disc 120, via plunger 122.

[0152] It is noted that biasing spring element 132 is preferably a folded over leaf spring element, having a portion 172 seated on a top surface of plunger 122. Preferably, portion 172 of spring element 132 is formed with an aperture 174 which engages a protrusion 176 at the top of plunger 122. A bend 178 of biasing spring element 132 is seated in a recess 180 defined in the interior of top housing portion 103 and an end 182 of spring element 132 engages an interior wall 184 of top housing portion 103. Both bend 178 and end 182 are restricted in their lateral motion, while end 182 is relatively unrestricted in its motion parallel to axis 138. Cam contact location 170 preferably is defined by a protrusion 186 formed in spring element 132 between the bend 178 and the end 182.

[0153] Alternatively, the spring element 132 may comprise any suitable spring element, such as a spiral spring or a helical spring.

[0154] It is appreciated that in order that ambient temperature independent operation of the spraying device may occur, as described hereinabove with reference to Figs. 3A - 5B, in uniformity of interval between sprays, the higher the ambient temperature, the smaller must be the biasing force on the bimetallic disc 120.

[0155] A typical ambient temperature range of operation for the spraying device is between 20 and 30 degrees centigrade. In such an example, Fig. 5A represents operation at approximately 30 degrees centigrade.

[0156] Accordingly, when the ambient temperature outside the spray dispenser 100 decreases, as seen in Fig. 5B, for example to 25 degrees centigrade, the cam 134 is at a position corresponding to a temperature at the middle range of the predetermined range of ambient temperatures outside the spray dispenser 100. Here an intermediate cam thickness is provided between axis 142 and cam contact location 170 on biasing spring element 132, applying an intermediate biasing force along axis 138 to bimetallic disc 120, via plunger 122.

[0157] Similarly, when the ambient temperature outside the spray dispenser 100 decreases further, as seen in Fig. 5C, for example to 20 degrees centigrade, the cam 134 is at a position corresponding to a temperature at the lower range of the predetermined

range of ambient temperatures outside the spray dispenser 100. Here a maximum thickness is provided between axis 142 and cam contact location 170 on biasing spring element 132, applying a maximum biasing force along axis 138 to bimetallic disc 120, via plunger 122.

[0158] Reference is now made to Fig. 5D, which illustrates a situation where the ambient temperature outside the spray dispenser 100 is outside the range of operation of the spray dispenser 100, being either greater than the maximum operation temperature or less than the minimum operation temperature. Here, the cam 134 is at a position where the cam thickness between axis 142 and cam contact location 170 on biasing spring element 132 is sufficiently small such that it provides either no force or a sufficiently low biasing force to the bimetallic disc 120, such that the bimetallic disc 120 is retained in place but does not shift to a spray orientation.

[0159] Preferably, a bimetallic disc with a shift actuating temperature relatively higher than the maximum operation temperature of the range of operation of the spray dispenser 100 is employed so as to eliminate or minimize shifting of the bimetallic disc when the ambient temperature outside the spray dispenser 100 is greater than the maximum operation temperature.

[0160] Reference is now made to Fig. 6, which is a simplified pictorial illustration of a spray dispenser 200 constructed and operative in accordance with another preferred embodiment of the present invention and mounted on a conventional pressurized aerosol container. As seen in Fig. 6, the spray dispenser 200 comprises a housing 201, preferably including a bottom housing portion 202 and a top housing portion 203. Bottom housing portion 202 is preferably configured to define a plurality of radially distributed inward facing resilient prongs 204, which resiliently engage a cover 205 of a container opening valve 206 of a conventional pressurized aerosol container 208.

[0161] It is noted that pressurized aerosol container 208 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0162] Mounted onto top housing portion 203 is a spray nozzle 212 of any suitable configuration. It is appreciated that a plurality of spray nozzles may be provided.

[0163] Reference is now made to Fig. 7, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 200 of Fig. 6. . An intermittent dispensing assembly comprising a temperature responsive shifting element in the form of a bimetallic disc 220 of any suitable configuration is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 208. This is preferably achieved by a plunger 222, which is loosely mounted onto bimetallic disc 220 and is preferably seated within a slotted ring 223. Alternatively, plunger 222 may be integrally formed with or welded to bimetallic disc 220.

[0164] It is noted that the bimetallic disc 220 is preferably loosely mounted within the spray dispenser 200 so as to allow the bimetallic disc 220 to assume its appropriate operational orientation corresponding to temperature changes within the spray dispenser 200, as will be described hereinbelow.

[0165] A lower portion 224 of plunger 222 preferably engages a ball 226 of a spray release valve 228. Plunger 222 also includes an upper portion 230, which is engaged by a biasing spring element 232. Biasing spring element 232 is in turn biased by a screw 234 extending below an upper portion 236 of top housing portion 203 and is threadably mounted within top housing portion 203. Selective biasing of bimetallic disc 220 takes place along an axis 238.

[0166] It is noted that biasing spring element 232 is preferably a folded over leaf spring element, having a first portion 252 seated on a top surface of plunger 222. Preferably, first portion 252 of spring element 232 is formed with an aperture 254 which engages a protrusion 256 at the top of plunger 222 while a second portion 258 of spring element 232 is formed with an aperture 260 which engages a protrusion 262 at the bottom of screw 234.

[0167] Upper portion 236 of top housing portion 203 is formed with a rotatably adjustable knob 264. User rotation of rotatably adjustable knob 264, and thus of the screw 234 causes a fixed force to be applied to the biasing spring element 232 thus enabling a user to select a user defined time interval between sprays, or, alternatively, to select a user defined spray initiation temperature. The force applied to the biasing spring element 232 is predetermined to provide operation of the spray dispenser 200 corresponding to the user selection. The biasing spring element 232 applies a fixed force along axis 238 to bimetallic disc 220, via plunger 222, thus providing for the spray

dispenser 200 to generally operate within the selected time interval between sprays, as shown in Fig. 10A, or, alternatively, for the spray dispenser 200 to dispense the fluid generally at the spray initiation temperature, as shown in Fig. 10B.

[0168] As seen in Fig. 7, the rotation of the knob 264 is limited by a limiting pin 266 seated within a circular slot 268 formed in upper portion 236. The limiting pin 266 limits user rotation of the knob 264 and thus of the screw 234 so as to prevents the biasing spring element 232 from applying a force to the bimetallic disc 220, which will cause the bimetallic disc 220 to shift outside the range of operation of the spray dispenser 200.

[0169] Reference is now made to Figs. 8A & 8B, which are sectional illustrations of the spray dispenser 200 of Fig. 6, taken along lines VIII - VIII in Fig. 6 in respective spraying and non-spraying operative orientations and to Figs. 9A and 9B, which are sectional illustrations of the spray dispenser 200 of Figs. 8A & 8B, taken along lines IXA - IXA and IXB - IXB respectively, wherein Fig. 9A also includes an insert which shows an enlarged section taken along lines A - A in Fig. 9A. When the spray dispenser 200 of Figs. 6 - 8B is initially mounted onto the pressurized aerosol container 208, a discharge orifice element 270 of the container opening valve 206 of the pressurized aerosol container 208 is engaged in a recess 272 formed at the bottom of bottom housing portion 202. A top surface 274 of the discharge orifice element 270 is sealingly engaged by an actuator operative to allow fluid to be released from the interior of the pressurized aerosol container 208 into the spray dispenser 200, via discharge orifice element 270. The actuator, preferably defined by a shoulder 276 of recess 272, pushes top surface 274 towards container opening valve 206, thereby depressing discharge orifice element 270 and thus the container opening valve 206 is maintained in a substantially open position.

[0170] It is noted that when the ambient temperatures are above a predetermined shift actuating temperature the bimetallic disc 220 of the spray dispenser 200 is located in a lowered spraying orientation, as seen in Fig. 8A. In this lowered spraying orientation the lower portion 224 of plunger 222, which extends below bimetallic disc 220, preferably engages ball 226 of spray release valve 228, forcing it away from its valve seat 277 and thus opening spray release valve 228. Accordingly, release of pressurized fluid, via discharge orifice element 270, produces a flow of fluid past ball

226 and around bottom portion 224 of plunger 222. Part of the fluid enters a volume 278 surrounding bimetallic disc 220 and exits through spray nozzle 212. It is appreciated that spray release valve 228 may be obviated and plunger 222 may directly engage discharge orifice element 270 so as to allow pressurized fluid flow from container opening valve 206 into the spray dispenser 200.

[0171] Volume 278 is defined by inclined walls 259 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 212 for release during a subsequent discharge of fluid via spray nozzle 212 to the ambient.

[0172] As seen particularly clearly in the insert in Fig. 9A, part of the fluid passes around bimetallic disc 220, via passageways 280 formed in housing 201, and expands in an upper portion 282 of volume 278 lying above bimetallic disc 220, as shown in Figs. 8A and 8B, permitting vaporization of the fluid within volume 278 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 212. Evaporation of the fluid released from pressurized aerosol container 208 (Figs. 6 - 8B) both above and below the bimetallic disc 220 provides cooling of both top and bottom surfaces of bimetallic disc 220 to a raised orientation shift actuating temperature, causing it to shift its orientation from a lowered spraying orientation, as shown in Fig. 8A, to a raised non-spraying orientation, as shown in Fig. 8B.

[0173] In this non-spraying orientation, the lower portion 224 of the plunger 222 does not dislodge the ball 226 from its valve seat 277 in the spray release valve 228, thus preventing outflow of fluid therepast. The fluid pressure of the aerosol in pressurized aerosol container 208 maintains the ball 226 in seated, sealing engagement, with its valve seat 277, such that spray release valve 228 remains closed.

[0174] Following termination of fluid flow from pressurized aerosol container 208 past bimetallic disc 220, the ambient temperature in the spray dispenser 200 gradually rises above the predetermined shift actuating temperature, and the bimetallic disc 220 is gradually warmed to a lowered orientation shift actuating temperature, until the bimetallic disc 220 once again assumes the lowered spraying orientation shown in Figs. 8A and 9A.

[0175] It is noted that by rotation of rotatably adjustable knob 264, as described with reference to Fig. 7, a biasing force is applied to the bimetallic disc 220. The biasing

force allows the bimetallic disc 220 to shift its orientation at a shift actuating temperature in accordance with a user selection.

[0176] It is noted that the selected time interval between sprays and the selected spray initiation temperature are dependent on ambient temperature variations within the range of operation of the spray dispenser 200. More specifically, the operation of the bimetallic disc 220 between its lowered spraying orientation, as shown in Fig. 8A, and its raised non-spraying orientation, as shown in Fig. 8B, is naturally dependent on the ambient temperature, which determines the rate at which the temperature of the bimetallic disc changes. Thus, when the ambient temperature decreases the warming of the bimetallic disc 220 is slowed and correspondingly its assumption of the lowered spraying orientation of Fig. 8A is delayed.

[0177] It is further noted that a relatively large upper portion 282 of volume 278 is shown in Figs. 8A and 8B. This relatively large upper portion 282 of volume 278 allows for relatively long residence of the fluid within the spray dispenser 200, producing enhanced vaporization and enhanced dissipation thereof and reducing the incidence of liquid droplets in the aerosol spray exiting spray nozzle 212. Should a smaller upper portion 282 of volume 278 be provided, a relatively greater incidence of liquid droplets in the aerosol spray can be expected to occur.

[0178] Reference is now made to Figs. 10A & 10B, which are each a simplified top view illustration of an embodiment of the spray dispenser 200 of Fig. 6. As seen in Fig. 10A, a user may rotate a rotatably adjustable knob, designated by reference numeral 264, so as to select a time interval between sprays, as described hereinabove with reference to Fig. 7. Alternatively, as shown in Fig. 10B, a user may rotate a rotatably adjustable knob, here designated by reference numeral 290, so as to select a spray initiation temperature in a manner similar to that described hereinabove with reference to knob 264 in Fig. 7.

[0179] Reference is now made to Fig. 11, which is a simplified pictorial illustration of a spray dispenser 300 constructed and operative in accordance with yet another preferred embodiment of the present invention and mounted on a conventional pressurized aerosol container. As seen in Fig. 11, the spray dispenser 300 comprises a housing 301, preferably including a bottom housing portion 302 and a top housing portion 303. Bottom housing portion 302 is preferably configured to define a plurality

of radially distributed inward facing resilient prongs 304, which resiliently engage a cover 305 of a container opening valve 306 of a conventional pressurized aerosol container 308.

[0180] It is noted that pressurized aerosol container 308 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0181] Mounted onto top housing portion 303 is a spray nozzle 312 of any suitable configuration. It is appreciated that a plurality of spray nozzles may be provided.

[0182] As seen in an insert of Fig. 11, the prongs 304 are provided on a bottom portion thereof with inward facing legs 314, which engage the pressurized aerosol container 308 at a contact location 316 adjacent to an outward protruding portion of cover 305 of the container opening valve 306 so as to prevent removal of the spray dispenser 300 from the pressurized aerosol container 308.

[0183] Prongs 304 and legs 314 are preferably formed of a resilient material, such as a resilient plastic so as to allow spray dispenser 300 to resiliently engage container 308 without use of rings or other tightening means.

[0184] Reference is now made to Fig. 12, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 300 of Fig. 11. A bimetallic element of any suitable configuration, such as a bimetallic disc 320, is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 308. This is preferably achieved by a plunger 322, which is loosely mounted onto bimetallic disc 320 and is preferably seated within a slotted ring 323. Alternatively, plunger 322 may be integrally formed with or welded to bimetallic disc 320.

[0185] It is noted that the bimetallic disc 320 is preferably loosely mounted within the spray dispenser 300 so as to allow the bimetallic disc 320 to assume its appropriate operational orientation corresponding to temperature changes within the spray dispenser 300, as will be described hereinbelow.

[0186] A lower portion 324 of plunger 322 preferably engages a ball 326 of a spray release valve 328. Plunger 322 also includes an upper portion 330, which is engaged by a biasing spring element 332, preferably in the form of a coiled spring. Biasing spring element 332 is in turn biased by a screw 334 extending below an upper

portion 336 of top housing portion 303 and is threadably mounted within top housing portion 303. Selective biasing of bimetallic disc 320 takes place along an axis 338.

[0187] Upper portion 336 of top housing portion 303 is formed with a rotatably adjustable knob 364. User rotation of rotatably adjustable knob 364, and thus of the screw 334, causes a fixed force to be applied to the biasing spring element 332 thus enabling the user to select a user defined time interval between sprays, or, alternatively, to select a user defined spray initiation temperature. The force applied to the biasing spring element 332 is predetermined to provide operation of the spray dispenser 300 corresponding to the user selection. The biasing spring element 332 applies a fixed force along axis 338 to bimetallic disc 320, via plunger 322, thus providing for the spray dispenser 300 to generally operate within the selected time interval between sprays, as shown in Fig. 15A, or, alternatively, for the spray dispenser 300 to dispense the fluid generally at the spray initiation temperature as shown in Fig. 15B. A limiting pin 366 is provided to limit user rotation of the knob 364, and thus of the screw 334, thereby preventing the biasing spring element 332 from applying an excessive force that may cause the bimetallic disc 320 to shift outside the range of operation of the spray dispenser 300.

[0188] Reference is now made to Figs. 13A, 13B and 13C which are sectional illustrations of the spray dispenser 300 of Fig. 11, taken along lines XIII - XIII in Fig. 11 in three operative orientations and to Figs. 14A and 14B, which are sectional illustrations of the spray dispenser 300 of Figs. 13B & 13C, taken along lines XIVA - XIVA and XIVB - XIVB respectively, wherein Fig. 14B also includes an insert which shows an enlarged section taken along lines A - A in Fig. 14B.

[0189] As seen in Fig. 13A, a flow prevention element 368, formed with a recess 369, is operative to retain ball 326 of spray release valve 328 within its valve seat 370 so as to prevent release of aerosol spray from pressurized aerosol container 308, for example, during initial mounting of the spray dispenser 300 onto the pressurized aerosol container 308.

[0190] When the spray dispenser 300 of Figs. 11 – 13C is initially mounted onto the pressurized aerosol container 308 flow prevention element 368 is positioned, as shown in Fig. 13A, to prevent fluid flow to spray release valve 328. As seen in Figs. 13B and 13C, flow prevention element 368 is positioned to allow fluid flow from

pressurized aerosol container 308 to spray release valve 328. A discharge orifice element 371 of the container opening valve 306 of the pressurized aerosol container 308 is engaged in a recess 372 formed at the bottom of bottom housing portion 302. A top surface 374 of the discharge orifice element 371 is sealingly engaged by an actuator operative to allow fluid to be released from the interior of the pressurized aerosol container 308 into the spray dispenser 300, via discharge orifice element 371. The actuator, preferably defined by a shoulder 376 of recess 372, pushes top surface 374 towards container opening valve 306, thereby depressing discharge orifice element 371 and thus the container opening valve 306 is maintained in a substantially open position.

[0191] Flow prevention element 368 is operative to be positioned by a user in a position which prevents fluid from reaching the spray release valve 328 and thus prevents fluid from exiting spray nozzle 312, as seen in Fig. 13A. Flow prevention element 368 may also be positioned to prevent fluid from reaching the spray release valve 328 during shipment and storage thereby preventing unwanted fluid discharge from spray dispenser 300.

[0192] The flow prevention element 368 operates as an on-off switch and allows the spray dispenser 300 to be mounted on the pressurized aerosol container 308 in accordance with methods not conveniently preformed by a user.

[0193] It is noted that when ambient temperatures are above a predetermined shift actuating temperature, the bimetallic disc 320 of the spray dispenser 300 is located in a lowered spraying orientation, as seen in Fig. 13C. In this lowered spraying orientation, lower portion 324 of plunger 322, which extends below bimetallic disc 320, preferably engages ball 326 of spray release valve 328, forcing it away from its valve seat 370 and thus opening spray release valve 328. Accordingly, release of pressurized fluid, via discharge orifice element 371, produces a flow of fluid past ball 326 and around bottom portion 324 of plunger 322. Part of the fluid enters a volume 378 underlying bimetallic disc 320 and exits through spray nozzle 312. It is appreciated that spray release valve 328 may be obviated and plunger 322 may directly engage discharge orifice element 371 so as to allow pressurized fluid flow from container opening valve 306 into the spray dispenser 300.

[0194] Volume 378 is defined by inclined walls 379 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 312 for release during a subsequent discharge of fluid via spray nozzle 312 to the ambient.

[0195] As seen particularly clearly in the insert in Fig. 14B, part of the fluid passes around bimetallic disc 320, via passageways 380, formed in housing 301, and expands in a volume 382 lying above bimetallic disc 320, as shown in Figs. 13A, 13B and 13C permitting vaporization of the fluid within volumes 378 and 382 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 312. Evaporation of the fluid released from pressurized aerosol container 308 (Figs. 11 – 13C), both above and below the bimetallic disc 320, provides cooling of both top and bottom surfaces of the bimetallic disc 320 to a raised orientation shift actuating temperature, causing it to shift its orientation from a lowered spraying orientation, as shown in Fig. 13C to a raised non-spraying orientation, as shown in Fig. 13B. In this non-spraying orientation, the lower portion 324 of the plunger 322, does not dislodge the ball 326 from its valve seat 370 in the spray release valve 328, thus preventing outflow of fluid therepast. The fluid pressure of the aerosol in pressurized aerosol container 308 maintains the ball 326 in seated, sealing engagement, with its valve seat 370, such that spray release valve 328 remains closed.

[0196] It is noted that by rotation of rotatably adjustable knob 364, as described with reference to Fig. 12, a biasing force is applied to the bimetallic disc 320. The biasing force allows the bimetallic disc 320 to shift its orientation at a shift actuating temperature in accordance with a user selection.

[0197] Following termination of fluid flow from pressurized aerosol container 308 past bimetallic disc 320, the ambient temperature in the spray dispenser 300 gradually rises above the predetermined shift actuating temperature and the bimetallic disc 320 is gradually warmed to a lowered orientation shift actuating temperature, until the bimetallic disc 320 once again assumes the lowered spraying orientation shown in Figs. 13C and 14B.

[0198] It is noted that the selected time interval between sprays and the selected spray initiation temperature are dependent on ambient temperature variations within the range of operation of the spray dispenser 300. More specifically, the operation of the bimetallic disc 320 between its lowered spraying orientation, as shown in Fig. 13C, and

its raised non-spraying orientation, as shown in Fig. 13B, is naturally dependent on the ambient temperature, which determines the rate at which the temperature of the bimetallic disc 320 changes. Thus, when the ambient temperature decreases, the warming of the bimetallic disc 320 is slowed and correspondingly its assumption of the lowered spraying orientation of Fig. 13C is delayed.

[0199] It is further noted that a relatively large volume 382 is shown in Figs. 13A, 13B and 13C. This relatively large volume allows for relatively long residence of the fluid within the spray dispenser 300, producing enhanced vaporization and enhanced dissipation thereof and reducing the incidence of liquid droplets in the aerosol spray exiting spray nozzle 312. Should a smaller volume 382 be provided, a relatively greater incidence of liquid droplets in the aerosol spray can be expected to occur.

[0200] Reference is now made to Figs. 15A & 15B, which are each a simplified top view illustration of an embodiment of the spray dispenser 300 of Fig. 11. As seen in Fig. 15A, a user may rotate a rotatably adjustable knob, designated by reference numeral 364, so as to select a time interval between sprays, as described hereinabove with reference to Fig. 12. Alternatively, as shown in Fig. 15B, a user may rotate a rotatably adjustable knob, here designated by reference numeral 390, so as to select a spray initiation temperature, in a manner similar to that described hereinabove with reference to knob 364 in Fig. 12.

[0201] Reference is now made to Fig. 16, which is a simplified pictorial illustration of a spray dispenser 400 constructed and operative in accordance with still another preferred embodiment of the present invention and mounted on a conventional pressurized aerosol container. As seen in Fig. 16, the spray dispenser 400 comprises a housing 401, preferably including a bottom housing portion 402 and a top housing portion 403. Bottom housing portion 402 is preferably configured to define a plurality of radially distributed inward facing resilient prongs 404, which resiliently engage a cover 405 of a container opening valve 406 of a conventional pressurized aerosol container 408.

[0202] It is noted that pressurized aerosol container 408 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0203] Mounted onto top housing portion 403 is a spray nozzle 412 of any suitable configuration. The spray dispenser 400 is also provided with a thermometer 414 so as to indicate to a user the ambient temperature outside the spray dispenser 400. It is appreciated that a plurality of spray nozzles may be provided.

[0204] Reference is now made to Fig. 17, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 400 of Fig. 16. A bimetallic disc 420 of any suitable configuration is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 408. This is preferably achieved by a plunger 422, which is loosely mounted onto bimetallic disc 420 and is preferably seated within a slotted ring 423. Alternatively, plunger 422 may be integrally formed with or welded to bimetallic disc 420.

[0205] It is noted that the bimetallic disc 420 is preferably loosely mounted within the spray dispenser 400 so as to allow the bimetallic disc 420 to assume its appropriate operational orientation corresponding to temperature changes within the spray dispenser 400, as will be described hereinbelow.

[0206] A lower portion 424 of plunger 422 preferably defines a pin 426 of a spray release valve 428. Plunger 422 also includes an upper portion 430, which is engaged by a biasing spring element 432, which is preferably in the form of a coiled spring. Biasing spring element 432 is in turn biased by a screw 434 extending below an upper portion 436 of top housing portion 403. Screw 434 is threadably mounted within top housing portion 403. Selective biasing of bimetallic disc 420 takes place along an axis 438.

[0207] Upper portion 436 of top housing portion 403 is formed with a rotatably adjustable knob 464. User rotation of rotatably adjustable knob 464, and thus of the screw 434, causes a fixed force to be applied to the biasing spring element 432 thus enabling the user to select a user defined spray initiation temperature. The force applied to the biasing spring element 432 is predetermined to provide operation of the spray dispenser 400 corresponding to the user selection. The biasing spring element 432 applies a fixed force along axis 438 to bimetallic disc 420, via plunger 422, thus providing for the spray dispenser 400 to dispense the fluid generally at the spray initiation temperature, as illustrated hereinbelow in reference to Fig. 20.

[0208] A limiting pin 466 is provided to limit user rotation of the knob 464, and thus of the screw 434, thereby preventing the biasing spring element 432 from applying an excessive force to the bimetallic disc 420 that may cause the bimetallic disc 420 to shift outside the range of operation of the spray dispenser 400.

[0209] Reference is now made to Figs. 18A, 18B & 18C, which are sectional illustrations of the spray dispenser 400 of Fig. 16, taken along lines XVIII - XVIII in Fig. 16 in three operative orientations and to Figs. 19A and 19B, which are sectional illustrations of the spray dispenser 400 of Figs. 18B & 18C, taken along lines XIXA - XIXA and XIXB - XIXB respectively, wherein Fig. 19B also includes an insert which shows an enlarged section taken along lines A - A in Fig. 19B.

[0210] As seen in Fig. 18A, a flow prevention element 468 also seen in Fig. 16 and formed with a half-cylindrical engagement portion 469, is operative to engage a shoulder of plunger 422 so as to retain pin 426 within its valve seat 470 so as to prevent release of aerosol spray from pressurized aerosol container 408, for example, during initial mounting of the spray dispenser 400 onto the pressurized aerosol container 408.

[0211] When the spray dispenser 400 of Figs. 16 - 18C is initially mounted onto the pressurized aerosol container 408 flow prevention element 468 is positioned, as shown in Fig. 18A, to prevent fluid flow to spray release valve 428. As seen in Figs. 18B and 18C, flow prevention element 468 is positioned to allow fluid flow from pressurized aerosol container 408 to spray release valve 428. A discharge orifice element 471 of the container opening valve 406 of the pressurized aerosol container 408 is engaged in a recess 472 formed at the bottom of bottom housing portion 402. A top surface 473 of the discharge orifice element 471 is sealingly engaged by an actuator operative to allow fluid to be released from the interior of the pressurized aerosol container 408 into the spray dispenser 400, via discharge orifice element 471. The actuator, preferably defined by a shoulder 474 of recess 472, pushes top surface 473 towards container opening valve 406, thereby depressing discharge orifice element 471 and thus the container opening valve 406 is maintained in a substantially open position.

[0212] Flow prevention element 468 is operative to be positioned by a user in a position which prevents fluid from reaching the spray release valve 428 and thus prevents fluid from exiting spray nozzle 412, as seen in Fig. 18A. Flow prevention element 468 may also be positioned to prevent fluid from reaching the spray release

valve 428 during shipment and storage thereby preventing unwanted fluid discharge from spray dispenser 400.

[0213] It is noted that when ambient temperatures are above a predetermined shift actuating temperature, the bimetallic disc 420 of the spray dispenser 400 is located in a raised spraying orientation, as seen in Fig. 18C. In the raised spraying orientation it is seen that pin 426 is preferably dislodged from an aperture 475 defined by an O-ring 476, which is seated in a recess defined in bottom housing portion 402, thus opening spray release valve 428. Accordingly, release of pressurized fluid, via discharge orifice element 471, produces a flow of fluid past aperture 475 and around bottom portion 424 of plunger 422. Part of the fluid enters a volume 478 underlying bimetallic disc 420 and exits through spray nozzle 412. It is appreciated that spray release valve 428 may be obviated and plunger 422 may directly engage discharge orifice element 471 so as to allow pressurized fluid flow from container opening valve 406 into the spray dispenser 400.

[0214] Volume 478 is defined by inclined walls 479 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 412 for release during a subsequent discharge of fluid via spray nozzle 412 to the ambient.

[0215] As seen particularly clearly in the insert in Fig. 19B, part of the fluid passes around bimetallic disc 420, via passageways 480 formed in housing 401, and expands in a volume 482 lying above bimetallic disc 420, as shown in Figs. 18A, 18B and 18C, permitting vaporization of the fluid within volumes 478 and 482 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 412. Evaporation of the fluid released from pressurized aerosol container 408, both above and below the bimetallic disc 420, provides cooling of both top and bottom surfaces of bimetallic disc 420 to a lowered orientation shift actuating temperature, causing it to shift its orientation from a raised spraying orientation, as shown in Fig. 18C, to a lowered non-spraying orientation, as shown in Fig. 18B. In this non-spraying orientation, the pin 426 of the plunger 422 is not dislodged from aperture 475, thus preventing outflow of fluid therepast.

[0216] Following termination of fluid flow from pressurized aerosol container 408 past bimetallic disc 420, the ambient temperature in the spray dispenser 400 gradually rises above the predetermined shift actuating temperature, and the bimetallic

disc 420 is gradually warmed to a raised orientation shift actuating temperature, until the bimetallic disc 420 once again assumes the raised spraying orientation shown in Figs. 18C and 19B.

[0217] It is noted that by rotation of rotatably adjustable knob 464, as described with reference to Fig. 17, a biasing force is applied to the bimetallic disc 420. The biasing force allows the bimetallic disc 420 to shift its orientation at a shift actuating temperature in accordance with a user selection.

[0218] It is noted that the selected spray initiation temperature is dependent on ambient temperature variations within the range of operation of the spray dispenser 400. More specifically, the operation of the bimetallic disc 420 between its raised spraying orientation, as shown in Fig. 18C, and its lowered non-spraying orientation, as shown in Fig. 18B, is naturally dependent on the ambient temperature, which determines the rate at which the temperature of the bimetallic disc changes. Thus, when the ambient temperature decreases, the warming of the bimetallic disc 420 is slowed and correspondingly its assumption of the raised spraying orientation of Fig. 18C is delayed.

[0219] It is further noted that a relatively small volume 482 is shown in Figs. 18A, 18B and 18C. This relatively small volume allows for relatively short residence of the fluid within the spray dispenser 400, increasing the incidence of liquid droplets in the aerosol spray exiting spray nozzle 412.

[0220] Reference is now made to Fig. 20, which is a simplified top view illustration of the spray dispenser 400 of Fig. 16. As seen in Fig. 20, a user may rotate rotatably adjustable knob 464 so as to select a spray initiation temperature.

[0221] Reference is now made to Fig. 21, which is a simplified pictorial illustration of a spray dispenser 500 constructed and operative in accordance with a further preferred embodiment of the present invention and mounted on a conventional pressurized aerosol container. As seen in Fig. 21, the spray dispenser 500 comprises a housing 501, preferably including a bottom housing portion 502 and a top housing portion 503. Bottom housing portion 502 is preferably provided with a fastening element 504, which resiliently engages a top portion of a conventional pressurized aerosol container 508 having a container opening valve 510.

[0222] It is noted that pressurized aerosol container 508 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0223] Mounted onto top housing portion 503 is a spray nozzle 512 of any suitable configuration. It is appreciated that a plurality of spray nozzles may be provided.

[0224] Reference is now made to Fig. 22, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 500 of Fig. 21. A bimetallic disc 520 of any suitable configuration is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 508. This is preferably achieved by a plunger 522, which is loosely mounted onto bimetallic disc 520 and is preferably seated within a slotted ring 523. Alternatively, plunger 522 may be integrally formed with or welded to bimetallic disc 520.

[0225] It is noted that the bimetallic disc 520 is preferably loosely mounted within the spray dispenser 500 so as to allow the bimetallic disc 520 to assume its appropriate operational orientation corresponding to temperature changes within the spray dispenser 500, as will be described hereinbelow.

[0226] A lower portion 524 of plunger 522 preferably engages a ball 526 of a spray release valve 528. Plunger 522 also includes an upper portion 530, which is engaged by a biasing spring element 532, preferably in the form of a coiled spring. Biasing spring element 532 is in turn biased by a screw 534 extending below an upper portion 536 of top housing portion 503. Screw 534 is threadably mounted within top housing portion 503. Selective biasing of bimetallic disc 520 takes place along an axis 538.

[0227] Upper portion 536 of top housing portion 503 is formed with a rotatably adjustable knob 544. User rotation of rotatably adjustable knob 544, and thus of the screw 534, causes a fixed force to be applied to the biasing spring element 532 thus enabling the user to select a user defined time interval between sprays or, alternatively, to select a user defined spray initiation temperature. The force applied to the biasing spring element 532 is predetermined to provide operation of the spray dispenser 500 corresponding to the user selection. The biasing spring element 532 applies a fixed force along axis 538 to bimetallic disc 520, via plunger 522, thus providing for the spray

dispenser 500 to generally operate within the selected time interval between sprays as shown in Fig. 25A, or, alternatively, for the spray dispenser 500 to dispense the fluid generally at the spray initiation temperature, as shown in Fig. 25B.

[0228] A limiting pin 546 is provided to limit user rotation of the knob 544 and thus of the screw 534, thereby preventing the biasing spring element 532 from applying an excessive force to the bimetallic disc 520 that may cause the bimetallic disc 520 to shift outside the range of operation of the spray dispenser 500.

[0229] Top housing portion 503 is threadably mounted onto bottom housing portion 502. Top housing portion 503 and bottom housing portion 502 jointly define an internal volume 550 operative to relatively thermally isolate the bimetallic disc 520 from the ambient so as to provide enhanced ambient temperature independent operation of the spray dispenser 500 within a predetermined range of ambient temperatures.

[0230] Reference is now made to Figs. 23A & 23B, which are sectional illustrations of the spray dispenser 500 of Fig. 21, taken along lines XXIII - XXIII in Fig. 21 in respective spraying and non-spraying operative orientations and to Figs. 24A and 24B, which are sectional illustrations of the spray dispenser 500 of Figs. 23A & 23B, taken along lines XXIVA - XXIVA and XXIVB - XXIVB respectively, wherein Fig. 24A also includes an insert which shows an enlarged section taken along lines A - A in Fig. 24A. As seen in Fig. 23A, a mounting element 552 of the spray dispenser 500 of Figs. 21 - 23B is preferably mounted onto a discharge orifice element 554 of the pressurized aerosol container 508. When the spray dispenser 500 is initially mounted onto the pressurized aerosol container 508, the discharge orifice element 554 of the container opening valve 510 of the pressurized aerosol container 508 is engaged in a recess 572 formed in mounting element 552.

[0231] A top surface 574 of the discharge orifice element 554 is sealingly engaged by an actuator operative to allow fluid to be released from the interior of the pressurized aerosol container 508 into the spray dispenser 500, via discharge orifice element 554 and a conduit 576 formed in mounting element 552. The actuator, preferably defined by a shoulder 575 of recess 572, pushes top surface 574 towards container opening valve 510, thereby depressing discharge orifice element 554 and thus the container opening valve 506 is maintained in a substantially open position.

[0232] It is appreciated that mounting element 552 may accommodate different sizes of discharge orifice elements. Furthermore, mounting element 552 may be a removable mounting element which comprises a gripping portion, such as a gripping portion 577 constructed and operative for easy removal of mounting element 552 to be replaced by another mounting element. Alternatively, mounting element 552 may be obviated.

[0233] It is noted that when ambient temperatures are above a predetermined shift actuating temperature, the bimetallic disc 520 of the spray dispenser 500 is located in a lowered spraying orientation, as seen in Fig. 23A. In this lowered spraying orientation, lower portion 524 of plunger 522, which extends below bimetallic disc 520, preferably engages ball 526 of spray release valve 528, forcing it away from its valve seat and thus opening spray release valve 528. Accordingly, release of pressurized fluid, via discharge orifice element 554, produces a flow of fluid past ball 526 and around bottom portion 524 of plunger 522. Part of the fluid enters a volume 578 underlying bimetallic disc 520 and exits through spray nozzle 512.

[0234] Volume 578 is defined by inclined walls 579 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 512 for release during a subsequent discharge of fluid via spray nozzle 512 to the ambient.

[0235] As seen particularly clearly in the insert in Fig. 24A, part of the fluid passes around bimetallic disc 520, via passageways 580 formed in the top housing portion 503, and expands in a volume 582 lying above bimetallic disc 520, as shown in Figs. 23A and 23B, permitting vaporization of the fluid within volumes 578 and 582 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 512. Evaporation of the fluid released from pressurized aerosol container 508 (Figs. 21 - 23B), both above and below the bimetallic disc 520, provides cooling of both top and bottom surfaces of bimetallic disc 520 to a raised orientation shift actuating temperature, causing it to shift its orientation from a lowered spraying orientation, as shown in Fig. 23A to a raised non-spraying orientation, as shown in Fig. 23B. In this non-spraying orientation, the lower portion 524 of the plunger 523, does not dislodge the ball 526 from its valve seat in the spray release valve 528, thus preventing outflow of fluid therepast. The fluid pressure of the aerosol in pressurized aerosol container 508

maintains the ball 526 in seated, sealing engagement, with its valve seat, such that spray release valve 528 remains closed.

[0236] Following termination of fluid flow from pressurized aerosol container 508 past bimetallic disc 520, the ambient temperature in the spray dispenser 500 gradually rises above the predetermined shift actuating temperature and the bimetallic disc 520 is gradually warmed to a lowered orientation shift actuating temperature, until the bimetallic disc 520 once again assumes the lowered spraying orientation shown in Figs. 23A and 24A.

[0237] It is noted that by rotation of rotatably adjustable knob 544, as described with reference to Fig. 22, a biasing force is applied to the bimetallic disc 520. The biasing force allows the bimetallic disc 520 to shift its orientation at a shift actuating temperature in accordance with a user selection.

[0238] It is noted that although internal volume 550 is operative to relatively thermally isolate the bimetallic disc 520 from the ambient, so as to reduce the influence of the ambient temperature changes on the operation of the spray dispenser 500, the selected time interval between sprays and the selected spray initiation temperature are nevertheless somewhat dependent on ambient temperature variations within the range of operation of the spray dispenser 500. More specifically, the operation of the bimetallic disc 520 between its lowered spraying orientation, as shown in Fig. 23A, and its raised non-spraying orientation, as shown in Fig. 23B, is naturally dependent on the ambient temperature, which determines the rate at which the temperature of the bimetallic disc changes. Thus, when the ambient temperature decreases, the warming of the bimetallic disc 520 is slowed and correspondingly its assumption of the lowered spraying orientation of Fig. 23A is delayed.

[0239] Reference is now made to Figs. 25A & 25B, which are each a simplified top view illustration of an embodiment of the spray dispenser 500 of Fig. 21. As seen in Fig. 25A, a user may rotate a rotatably adjustable knob, designated by reference numeral 544, so as to select a time interval between sprays, as described hereinabove with reference to Fig. 22. Alternatively, as shown in Fig. 25B, a user may rotate a rotatably adjustable knob, here designated by reference numeral 590, so as to select a spray initiation temperature in a manner similar to that described hereinabove with reference to knob 544 in Fig. 22.

[0240] Reference is now made to Fig. 26, which is a simplified pictorial illustration of a spray dispenser 600 constructed and operative in accordance with a yet further preferred embodiment of the present invention and mounted on a conventional pressurized aerosol container. As seen in Fig. 26, the spray dispenser 600 comprises a housing 601, preferably including a bottom housing portion 602 and a top housing portion 603. Bottom housing portion 602 is preferably provided with a fastening element 604, which resiliently engages a top portion of a conventional pressurized aerosol container 608 having a container opening valve 610.

[0241] It is noted that pressurized aerosol container 608 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0242] Mounted onto top housing portion 603 is a spray nozzle 612 of any suitable configuration. It is appreciated that a plurality of spray nozzles may be provided.

[0243] Reference is now made to Fig. 27, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 600 of Fig. 26. A bimetallic disc 620 of any suitable configuration is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 608. This is preferably achieved by a plunger 622, which is loosely mounted onto bimetallic disc 620 and is preferably seated within a slotted ring 623. Alternatively, plunger 622 may be integrally formed with or welded to bimetallic disc 620.

[0244] It is noted that the bimetallic disc 620 is preferably loosely mounted within the spray dispenser 600 so as to allow the bimetallic disc 620 to assume its appropriate operational orientation corresponding to temperature changes within the spray dispenser 600, as will be described hereinbelow.

[0245] A lower portion 624 of plunger 622 preferably defines a pin 626 of a spray release valve 628. Plunger 622 also includes an upper portion 630, which is engaged by a biasing spring element 632, preferably in the form of a coiled spring. Biasing spring element 632 is in turn biased by a screw 634 extending below an upper portion 636 of top housing portion 603 and is threadably mounted within top housing portion 603. Selective biasing of bimetallic disc 620 takes place along an axis 638.

[0246] Upper portion 636 of top housing portion 603 is formed with a rotatably adjustable knob 644. User rotation of rotatably adjustable knob 644, and thus of the screw 634, causes a fixed force to be applied to the biasing spring element 632 thus enabling the user to select a user defined interval between sprays or, alternatively, to select a user defined spray initiation temperature. The force applied to the biasing spring element 632 is predetermined to provide operation of the spray dispenser 600 corresponding to the user selection. The biasing spring element 632 applies a fixed force along axis 638 to bimetallic disc 620, via plunger 622, thus providing for the spray dispenser 600 to generally operate within the selected time interval between sprays, as shown in Fig. 30A, or, alternatively, for the spray dispenser 600 to dispense the fluid generally at the spray initiation temperature, as shown in Fig. 30B.

[0247] A limiting pin 646 is provided to limit user rotation of the knob 644 and thus of the screw 634, thereby preventing the biasing spring element 632 from applying an excessive force to the bimetallic disc 620 that may cause the bimetallic disc 620 to shift outside the range of operation of the spray dispenser 600.

[0248] Top housing portion 603 is threadably mounted onto bottom housing portion 602. Top housing portion 603 and bottom housing portion 602 jointly define an internal volume 650 operative to relatively thermally isolate the bimetallic disc 620 from the ambient so as to provide enhanced ambient temperature independent operation of the spray dispenser 600 within a predetermined range of ambient temperatures.

[0249] Reference is now made to Figs. 28A and 28B, which are sectional illustrations of the spray dispenser 600 of Fig. 26, taken along lines XXVIII - XXVIII in Fig. 26 in two operative orientations and to Figs. 29A and 29B, which are sectional illustrations of the spray dispenser 600 of Figs. 28A & 28B, taken along lines XXIXA - XXIXA and XXIXB - XXIXB respectively, wherein Fig. 29A also includes an insert which shows an enlarged section taken along lines A - A in Fig. 29A.

[0250] As seen in Fig. 28A, a mounting element 652 of the spray dispenser 600 of Figs. 26 - 28B is preferably mounted onto a discharge orifice element 654 of the pressurized aerosol container 608. When the spray dispenser 600 is initially mounted onto the pressurized aerosol container 608, the discharge orifice element 654 of the container opening valve 610 of the pressurized aerosol container 608 is engaged in a recess 672 formed in mounting element 652.

[0251] A top surface 673 of the discharge orifice element 654 is sealingly engaged by an actuator operative to allow fluid to be released from the interior of the pressurized aerosol container 608 into the spray dispenser 600, via discharge orifice element 654 and a conduit 676 formed in mounting element 652. The actuator, preferably defined by a shoulder 674 of recess 672, pushes top surface 673 towards container opening valve 610, thereby depressing discharge orifice element 654 and thus the container opening valve 610 is maintained in a substantially open position.

[0252] It is appreciated that mounting element 652 may accommodate different sizes of discharge orifice elements. Furthermore, mounting element 652 may be a removable mounting element which comprises a gripping portion, such as a gripping portion 677 constructed and operative for easy removal of mounting element 652 to be replaced by another mounting element. Alternatively, mounting element 652 may be obviated.

[0253] It is noted that when ambient temperatures are above a predetermined shift actuating temperature, the bimetallic disc 620 of the spray dispenser 600 is located in a raised spraying orientation, as seen in Fig. 28A. In the raised spraying orientation it is seen that pin 626 is preferably dislodged from an aperture 678, preferably defined by an O-ring 680, which is seated in housing 601 and thus opening spray release valve 628. Accordingly, release of pressurized fluid, via discharge orifice element 654, produces a flow of fluid past aperture 678 and around bottom portion 624 of plunger 622. Part of the fluid enters a volume 682 underlying bimetallic disc 620 and exits through spray nozzle 612.

[0254] Volume 682 is defined by inclined walls 683 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 612 for release during a subsequent discharge of fluid via spray nozzle 612 to the ambient.

[0255] As seen particularly clearly in the insert in Fig. 29A, part of the fluid passes around bimetallic disc 620, via passageways 684 formed in the top housing portion 603, and expands in a volume 686 lying above bimetallic disc 620, as shown in Figs. 28A and 28B, permitting vaporization of the fluid within volumes 682 and 686 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 612. Evaporation of the fluid released from pressurized aerosol container 608, both above and below the bimetallic disc 620, provides cooling of both top and bottom surfaces of

bimetallic disc 620 to a lowered orientation shift actuating temperature, causing it to shift its orientation from a raised spraying orientation, as shown in Fig. 28A, to a lowered non-spraying orientation, as shown in Fig. 28B. In this non-spraying orientation, the pin 626 of the plunger 622 is not dislodged from aperture 678 thus preventing outflow of fluid therepast.

[0256] Following termination of fluid flow from pressurized aerosol container 608 past bimetallic disc 620, the ambient temperature in the spray dispenser 600 gradually rises above the predetermined shift actuating temperature, and the bimetallic disc 620 is gradually warmed to a raised orientation shift actuating temperature, until the bimetallic disc 620 once again assumes the raised spraying orientation shown in Figs. 28A and 29A.

[0257] It is noted that by rotation of rotatably adjustable knob 644, as described with reference to Fig. 27, a biasing force is applied to the bimetallic disc 620. The biasing force allows the bimetallic disc 620 to shift its orientation at a shift actuating temperature in accordance with a user selection.

[0258] It is noted that although internal volume 650 is operative to relatively thermally isolate the bimetallic disc 620 from the ambient, so as to reduce the influence of the ambient temperature changes on the operation of the spray dispenser 600, the selected time interval between sprays and the selected spray initiation temperature are nevertheless somewhat dependent on ambient temperature variations within the range of operation of the spray dispenser 600. More specifically, the operation of the bimetallic disc 620 between its raised spraying orientation, as shown in Fig. 28A, and its lowered non-spraying orientation, as shown in Fig. 28B, is naturally dependent on the ambient temperature, which determines the rate at which the temperature of the bimetallic disc changes. Thus, when the ambient temperature decreases, the warming of the bimetallic disc 620 is slowed and correspondingly its assumption of the raised spraying orientation of Fig. 28A is delayed.

[0259] Reference is now made to Figs. 30A & 30B, which are each a simplified top view illustration of an embodiment of the spray dispenser 600 of Fig. 26. As seen in Fig. 30A, a user may rotate a rotatably adjustable knob, designated by reference numeral 644, so as to select a time interval between sprays, as described hereinabove with reference to Fig. 27. Alternatively, as shown in Fig. 30B, a user may rotate a

rotatably adjustable knob, here designated by reference numeral 690, so as to select a spray initiation temperature, in a manner similar to that described hereinabove with reference to knob 644 in Fig. 27.

[0260] Reference is now made to Fig. 31, which is a simplified pictorial illustration of a spray dispenser 700 constructed and operative in accordance with a still further preferred embodiment of the present invention and mounted on a conventional pressurized aerosol container. As seen in Fig. 31, the spray dispenser 700 comprises a housing 701, preferably including a bottom housing portion 702 and a top housing portion 703. Bottom housing portion 702 is preferably configured to define a plurality of radially distributed inward facing resilient prongs 704, which resiliently engage a cover 705 of a container opening valve 706 of a conventional pressurized aerosol container 708.

[0261] It is noted that pressurized aerosol container 708 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0262] Mounted onto top housing portion 703 is a spray nozzle 712 of any suitable configuration. It is appreciated that a plurality of spray nozzles may be provided.

[0263] Reference is now made to Fig. 32, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 700 of Fig. 31. A bimetallic disc 720 of any suitable configuration is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 708. This is preferably achieved by a plunger 722, which is loosely mounted onto bimetallic disc 720 and is preferably seated within a slotted ring 723. Alternatively, plunger 722 may be integrally formed with or welded to bimetallic disc 720.

[0264] It is noted that the bimetallic disc 720 is preferably loosely mounted within the spray dispenser 700 so as to allow the bimetallic disc 720 to assume its appropriate operational orientation corresponding to temperature changes within the spray dispenser 700, as will be described hereinbelow.

[0265] A lower portion 724 of plunger 722 preferably engages a ball 726 of a spray release valve 728. Plunger 722 also includes an upper portion 730. Biasing of bimetallic disc 720 takes place along an axis 738.

[0266] Alternatively, spray release valve 728 may comprise a pin of the type shown in Figs. 17 – 18C and 27 – 28B. It is appreciated that the spray dispenser 700 may be provided with a flow prevention element, as shown in Figs. 12 – 13B and designated by reference numeral 368 or as shown in Figs. 17 – 18C and designated by reference numeral 468.

[0267] Reference is now made to Figs. 33A & 33B, which are sectional illustrations of the spray dispenser 700 of Fig. 31, taken along lines XXXIII - XXXIII in Fig. 31 in respective spraying and non-spraying operative orientations and to Figs. 34A and 34B, which are sectional illustrations of the spray dispenser 700 of Figs. 33A & 33B, taken along lines XXXIVA - XXXIVA and XXXIVB - XXXIVB respectively, wherein Fig. 34A also includes an insert which shows an enlarged section taken along lines A - A in Fig. 34A.

[0268] When the spray dispenser 700 of Figs. 31 - 33B is initially mounted onto the pressurized aerosol container 708, a discharge orifice element 770 of the container opening valve 706 of the pressurized aerosol container 708 is engaged in a recess 772 formed at the bottom of bottom housing portion 702. A top surface 774 of the discharge orifice element 770 is sealingly engaged by an actuator operative to allow fluid to be released from the interior of the pressurized aerosol container 708 into the spray dispenser 700, via discharge orifice element 770. The actuator, preferably defined by a shoulder 776 of recess 772, pushes top surface 774 towards container opening valve 706, thereby depressing discharge orifice element 770 and thus the container opening valve 706 is maintained in a substantially open position.

[0269] It is noted that when ambient temperatures are above a predetermined shift actuating temperature, the bimetallic disc 720 of the spray dispenser 700 is located in a lowered spraying orientation, as seen in Fig. 33A. In this lowered spraying orientation, lower portion 724 of plunger 722, which extends below bimetallic disc 720, preferably engages ball 726 of spray release valve 728, forcing it away from its valve seat 777 and thus opening spray release valve 728. Accordingly, release of pressurized fluid, via discharge orifice element 770, produces a flow of fluid past ball 726 and around bottom portion 724 of plunger 722. Part of the fluid enters a volume 778 underlying bimetallic disc 720 and exits through spray nozzle 712. It is appreciated that spray release valve 728 may be obviated and plunger 722 may directly engage discharge

orifice element 770 so as to allow pressurized fluid flow from container opening valve 706 into the spray dispenser 700.

[0270] Volume 778 is defined by inclined walls 779 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 712 for release during a subsequent discharge of fluid via spray nozzle 712 to the ambient.

[0271] I t is noted that surfaces of volume 778 may be made of a cold retaining material, such as aluminum, so as to delay the warming of the bimetallic disc 720 thereby lengthening the intervals between sprays.

[0272] As seen particularly clearly in the insert in Fig. 34A, part of the fluid passes around bimetallic disc 720, via passageways 780 formed in housing 701, and expands in a volume 782 lying above bimetallic disc 720, as shown in Figs. 33A and 33B, permitting vaporization of the fluid within volumes 778 and 782 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 712. Evaporation of the fluid released from pressurized aerosol container 708 (Figs. 31 - 33B) both above and below the bimetallic disc 720 provides cooling of both top and bottom surfaces of bimetallic disc 720 to a raised orientation shift actuating temperature, causing it to shift its orientation from a lowered spraying orientation, as shown in Fig. 33A, to a raised non-spraying orientation, as shown in Fig. 33B. In this non-spraying orientation, the lower portion 724 of the plunger 722 does not dislodge the ball 726 from its valve seat 777 in the spray release valve 728, thus preventing outflow of fluid therepast. The fluid pressure of the aerosol in pressurized aerosol container 708 maintains the ball 726 in seated, sealing engagement, with its valve seat 777, such that spray release valve 728 remains closed.

[0273] Following termination of fluid flow from pressurized aerosol container 708 past bimetallic disc 720, the ambient temperature in the spray dispenser 700 gradually rises above the predetermined shift actuating temperature and gradually warms the bimetallic disc 720 to a lowered orientation shift actuating temperature, until the bimetallic disc 720 once again assumes the lowered spraying orientation shown in Figs. 33A and 34A.

[0274] It is noted that a time interval between sprays is dependent on ambient temperature variations within the range of operation of the spray dispenser 700. More specifically, the operation of the bimetallic disc 720 between its lowered spraying

orientation, as shown in Fig. 33A, and its raised non-spraying orientation, as shown in Fig. 33B, is naturally dependent on the ambient temperature, which determines the rate at which the temperature of the bimetallic disc changes. Thus, when the ambient temperature decreases, the warming of the bimetallic disc 720 is slowed and, correspondingly, its assumption of the lowered spraying orientation of Fig. 33A is delayed.

[0275] It is further noted that a relatively large volume 782 is shown in Figs. 33A and 33B. This relatively large volume allows for relatively long residence of the fluid within the spray dispenser 700, producing enhanced vaporization and enhanced dissipation thereof and reducing the incidence of liquid droplets in the aerosol spray exiting spray nozzle 712. Should a smaller volume 782 be provided, a relatively greater incidence of liquid droplets in the aerosol spray can be expected to occur.

[0276] It is appreciated that the spray dispenser 700 shown hereinabove in Figs. 1– 5B and 11 - 34B may be transferred from one pressurized aerosol container to another.

[0277] Reference is now made to Fig. 35, which is a simplified pictorial illustration of a spray dispenser 800 constructed and operative in accordance with yet another preferred embodiment of the present invention and mounted on a pressurized aerosol container. As seen in Fig. 35, the spray dispenser 800 comprises a housing 801, preferably including a bottom housing portion 802 and a top housing portion 803. Spray dispenser 800 preferably is mounted on a pressurized aerosol container 808 comprising a dip tube 810.

[0278] It is noted that pressurized aerosol container 808 may contain any of a large variety of fluids including, for example, air, oxygen, fuels, water, oils, sterilizers, cleaning materials, insecticides and deodorants.

[0279] Mounted onto spray dispenser 800 is a spray nozzle 812 of any suitable configuration. It is appreciated that a plurality of spray nozzles may be provided. A flow prevention element 814 preferably is mounted onto bottom portion 802

[0280] Reference is now made to Fig. 36, which is a simplified pictorial illustration of principal operative elements of the spray dispenser 800 of Fig. 35. A bimetallic disc 820 of any suitable configuration is operative to intermittently actuate spraying of the contents of the pressurized aerosol container 808. This is preferably

achieved by a plunger 822, which is loosely mounted onto bimetallic disc 820 and is preferably seated within a slotted ring 823. Alternatively, plunger 822 may be integrally formed with or welded to bimetallic disc 820.

[0281] It is noted that the bimetallic disc 820 is preferably loosely mounted within the spray dispenser 800 so as to allow the bimetallic disc 820 to assume its appropriate operational orientation corresponding to temperature changes within the spray dispenser 800, as will be described hereinbelow.

[0282] A lower portion 824 of plunger 822 preferably engages a ball 826 of a spray release valve 828. Alternatively, spray release valve 828 may comprise a pin of the type shown in Figs. 17 – 18C and 27 – 28B. Plunger 822 also includes an upper portion 830, which is engaged by a biasing spring element 832, preferably in the form of a coiled spring. Biasing spring element 832 is in turn biased by a screw 834 extending below an upper portion 836 of top housing portion 803 and is threadably mounted within top housing portion 803. Selective biasing of bimetallic disc 820 takes place along an axis 838.

[0283] Upper portion 836 of top housing portion 803 is formed with a rotatably adjustable knob 864. User rotation of rotatably adjustable knob 864, and thus of the screw 834, causes a fixed force to be applied to the biasing spring element 832 thus enabling the user to select a user defined time interval between sprays, or, alternatively, to select a user defined spray initiation temperature. The force applied to the biasing spring element 832 is predetermined to provide operation of the spray dispenser 800 corresponding to the user selection. The biasing spring element 832 applies a fixed force along axis 838 to bimetallic disc 820, via plunger 822, thus providing for the spray dispenser 800 to generally operate within the selected time interval between sprays, as shown in Fig. 39A, or, alternatively, for the spray dispenser 800 to dispense the fluid generally at the spray initiation temperature, as shown in Fig. 39B.

[0284] A limiting pin 866 is provided to limit user rotation of the knob 864, and thus of the screw 834, thereby preventing the biasing spring element 832 from applying an excessive force that may cause the bimetallic disc 820 to shift outside the range of operation of the spray dispenser 800.

[0285] As seen in Fig. 36, an extension 870 of spray dispenser 800 is sealingly mounted in an aperture 872, which is formed in pressurized aerosol container 808 and is

defined by a top portion of dip tube 810. A recess 874 is formed in extension 870 and is in fluid communication with dip tube 810 and a conduit 876 formed in bottom housing portion 802 of spray dispenser 800. Recess 874 is preferably formed with a relatively small circumference so as to allow extension 870 to be stably mounted within aperture 872.

[0286] It is appreciated that the extension 870 may be sealingly inserted into dip tube 810 by applying techniques known in the art for inserting valve stems in a conventional aerosol container.

[0287] It is appreciated that in the present embodiment, described with reference to Figs. 35 – 39B, a container opening valve may be obviated.

[0288] Reference is now made to Figs. 37A, 37B and 37C which are sectional illustrations of the spray dispenser 800 of Fig. 35, taken along lines XXXVII - XXXVII in Fig. 35 in three operative orientations and to Figs. 38A and 38B, which are sectional illustrations of the spray dispenser 800 of Figs. 37B & 37C, taken along lines XXXVIIIA - XXXVIIIA and XXXVIIIB - XXXVIIIB respectively, wherein Fig. 38B also includes an insert which shows an enlarged section taken along lines A - A in Fig. 38B.

[0289] Flow prevention element 814, formed with a recess 880 on an end portion thereof, is operative, when positioned as seen in Fig. 37A, to retain ball 826 of spray release valve 828 within its valve seat 882 so as to prevent release of aerosol spray from pressurized aerosol container 808.

[0290] Flow prevention element 814 is operative to be positioned by a user in a position which prevents fluid from reaching the spray release valve 828 and thus prevents fluid from exiting spray nozzle 812, as seen in Fig. 37A. Flow prevention element 814 may also be positioned to prevent fluid from reaching the spray release valve 828 during shipment and storage thereby preventing unwanted fluid discharge from spray dispenser 800.

[0291] When flow prevention element 814 is positioned as seen in Figs. 37B and 37C fluid is allowed to flow from pressurized aerosol container 808 into spray dispenser 800, via a fluid passageway 884, which is defined by dip tube 810, recess 874 and conduit 876, to spray release valve 828.

[0292] It is noted that when ambient temperatures are above a predetermined shift actuating temperature, the bimetallic disc 820 of the spray dispenser 800 is located in a lowered spraying orientation, as seen in Fig. 37C. In this lowered spraying orientation, lower portion 824 of plunger 822, which extends below bimetallic disc 820, preferably engages ball 826 of spray release valve 828, forcing it away from its valve seat 882 and thus opening spray release valve 828. Accordingly, release of pressurized fluid, via passageway 884, produces a flow of fluid past ball 826 and around bottom portion 824 of plunger 822. Part of the fluid enters a volume 888 underlying bimetallic disc 820 and exits through spray nozzle 812.

[0293] Volume 888 is defined by inclined walls 889 on a bottom portion thereof so as to retain remaining fluid which did not exit spray nozzle 812 for release during a subsequent discharge of fluid via spray nozzle 812 to the ambient.

[0294] As seen particularly clearly in the insert in Fig. 38B, part of the fluid passes around bimetallic disc 820, via passageways 890, formed in housing 801, and expands in a volume 892 lying above bimetallic disc 820, as shown in Figs. 37A, 37B and 37C permitting vaporization of the fluid within volumes 888 and 892 and hence evaporation of the fluid therein prior to exit of the fluid via spray nozzle 812. Evaporation of the fluid released from pressurized aerosol container 808 (Figs. 35 – 37C), both above and below the bimetallic disc 820, provides cooling of both top and bottom surfaces of the bimetallic disc 820 to a raised orientation shift actuating temperature, causing it to shift its orientation from a lowered spraying orientation, as shown in Fig. 37C to a raised non-spraying orientation, as shown in Fig. 37B. In this non-spraying orientation, the lower portion 824 of the plunger 822, does not dislodge the ball 826 from its valve seat 882 in the spray release valve 828, thus preventing outflow of fluid therepast. The fluid pressure of the aerosol in pressurized aerosol container 808 maintains the ball 826 in seated, sealing engagement, with its valve seat 882, such that spray release valve 828 remains closed.

[0295] It is noted that a relatively large volume 892 is shown in Figs. 37A, 37B and 37C. This relatively large volume allows for relatively long residence of the fluid within the spray dispenser 800, producing enhanced vaporization and enhanced dissipation thereof and reducing the incidence of liquid droplets in the aerosol spray

exiting spray nozzle 812. Should a smaller volume 892 be provided, a relatively greater incidence of liquid droplets in the aerosol spray can be expected to occur.

[0296] Following termination of fluid flow from pressurized aerosol container 808 past bimetallic disc 820, the ambient temperature in the spray dispenser 800 gradually rises above the predetermined shift actuating temperature and the bimetallic disc 820 is gradually warmed to a lowered orientation shift actuating temperature, until the bimetallic disc 820 once again assumes the lowered spraying orientation shown in Figs. 37C and 38B.

[0297] It is noted that by rotation of rotatably adjustable knob 864, as described with reference to Fig. 36, a biasing force is applied to the bimetallic disc 820. The biasing force allows the bimetallic disc 820 to shift its orientation at a shift actuating temperature in accordance with a user selection.

[0298] It is noted that the selected time interval between sprays and the selected spray initiation temperature are dependent on ambient temperature variations within the range of operation of the spray dispenser 800. More specifically, the operation of the bimetallic disc 820 between its lowered spraying orientation, as shown in Fig. 37C, and its raised non-spraying orientation, as shown in Fig. 37B, is naturally dependent on the ambient temperature, which determines the rate at which the temperature of the bimetallic disc 820 changes. Thus, when the ambient temperature decreases, the warming of the bimetallic disc 820 is slowed and correspondingly its assumption of the lowered spraying orientation of Fig. 37C is delayed.

[0299] Reference is now made to Figs. 39A & 39B, which are each a simplified top view illustration of an embodiment of the spray dispenser 800 of Fig. 35. As seen in Fig. 39A, a user may rotate a rotatably adjustable knob, designated by reference numeral 864, so as to select a time interval between sprays, as described hereinabove with reference to Fig. 36. Alternatively, as shown in Fig. 39B, a user may rotate a rotatably adjustable knob, here designated by reference numeral 896, so as to select a spray initiation temperature in a manner similar to that described hereinabove with reference to knob 864 in Fig. 36.

[0300] It is appreciated that a temperature dependent biasing force application functionality described with reference to Fig. 5A – 5D may be employed to bias the spring biasing element 832 in place of rotation of rotatably adjustable knob 864 or 896.

[0301] Reference is now made to Figs. 40A and 40B, which illustrate a spray valve 1010 constructed and operative in accordance with a preferred embodiment of the present invention.

[0302] Spray valve 1010 preferably includes a dispenser body 1012 with an expansion chamber 1014 formed therein. Dispenser body 1012 may be sealingly connected to a container 1016 containing a fluid 1018, such as by means of an elastic metal ring 1024 which tightly fits into a groove 1026 formed at a bottom end of dispenser body 1012, in the same or similar manner as described in PCT patent application PCT/IL98/00618 and corresponding U.S. Patent 6,540,155. Fluid 1018 may be any kind of fluid, suitable for storing in container 1016 (under pressure or not), such as, but not limited to, deodorants, pesticides, fungicides, foodstuffs, paint, repellents, and the like. Container 1016 may be any kind of pressurized or non-pressurized container used in any of the applications described in PCT patent application PCT/IL98/00618. Container has a nozzle 1017 extending therefrom (Fig. 40A).

[0303] Dispenser body 1012 may include thermal insulation 1019, such as a plastic liner (single or multiple layers of insulation), or such as being constructed like a vacuum flask or with an insulating air pocket, for example.

[0304] A fluid outlet 1020 is preferably formed in dispenser body 1012 and is in fluid communication with expansion chamber 1014. In the embodiment of Figs. 40A and 40B, fluid outlet 1020 is located on a side of dispenser body 1012.

[0305] A plunger 1022 is preferably arranged for sliding motion in dispenser body 1012 between a first position (the position shown in Fig. 40A) and a second position (the position shown in Fig. 40B). Plunger 1022 can be brought into fluid communication with the fluid 1018 contained in container 1016 in a variety of manners. In the illustrated embodiment, an adapter 1028 is provided formed with a lower aperture 1029 which snugly fits over nozzle 1017 of container 1016. Different adapters 1028 with differently sized apertures 1029 may be provided for connection with any size nozzle 1017. An O-ring 1030 may be provided for sealing the fluid connection between adapter 1028 and container nozzle 1017. Adapter 1028 is formed with a longitudinal bore 1031.

[0306] Adapter 1028 fits in a bore 1032 formed in dispenser body 1012. Another O-ring 1034 may be provided for fluidly sealing adapter 1028 with respect to bore 1032.

An upper portion 1036 of adapter 1028 abuts against a guide member 1038. Preferably a third O-ring 1040 is provided to seal the fluid connection between adapter 1028 and guide member 1038. Guide member 1038 is formed with a bore 1042 in which slides plunger 1022. A lower portion of guide member 1038 is formed with a counterbore 1044 which extends from bore 1042.

[0307] In accordance with one preferred embodiment of the present invention, plunger 1022 is constructed as a hollow needle with a hole 1046 formed in a lower portion thereof and a hole 1048 formed at an upper end thereof (the hollow being shown in dashed lines in Fig. 40A). Alternatively, plunger 1022 may be formed as a non-hollow needle. A stop 1050 may be affixed to the upper end of plunger 1022 which limits the downward travel (in the sense of Fig. 40A) of plunger 1022. In the case of a hollow-needle plunger 1022, an O-ring 1052 and O-ring cover 1054 may be provided for fluidly sealing the upper end of plunger 1022 with guide member 1038 and stop 1050. In the case of a non-hollow plunger 1022, stop 1050, O-ring 1052 and O-ring cover 1054 are preferably omitted.

[0308] The skilled artisan will appreciate that the foregoing description of plunger 1022 and the various seals is just one example of countless other configurations of constructing and sealing plunger 1022, and that any configuration of plunger 1022 is within the scope of the present invention.

[0309] A deformable element 1056 is preferably mounted just above expansion chamber 1014 in dispenser body 1012. Deformable element 1056 may have any shape, such as circular, rectangular or square, for example. In the case of a circular, disc-shaped element, deformable element 1056 is not clamped around its periphery. Instead, deformable element 1056 is preferably freely supported around its periphery. In the embodiment illustrated in Figs. 40A and 40B, a plug 1053 preferably snugly fits in dispenser body 1012 and is preferably fastened thereto with a retaining ring 1047. The periphery of deformable element 1056 is placed, but not clamped, between a lower extension 1043 of plug 1053 and an O-ring 1058. As deformable element 1056 bends downwards or upwards (in the sense of Fig. 40A), deformable element 1056 merely rests on or slightly squeezes O-ring 1058, but there is generally no clamping force on deformable element 1056. The purpose of O-ring 1058 is to seal the expansion chamber 1014 which is situated below deformable element 1056 in the embodiment of Figs. 40A

and 40B. (In another embodiment, shown in Fig. 44, the expansion chamber is on both sides of the deformable element, and there is no need for an O-ring.) Thus deformable element 1056 is free to snap from one position to another without any clamping forces. Unlike the prior art, deformable element 1056 does not have the disadvantage of being sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement.

[0310] There is preferably a gap 1051 that extends radially between the peripheral edge of deformable element 1056 and the inner perimeter of expansion chamber 1014. Gap 1051 ensures that there are no radially-directed stresses acting upon deformable element 1056. In the case of a non-hollow plunger 1022 that is attached to deformable element 1056, gap 1051 enables plunger 1022 to self-center relative to stop 1050 and O-ring 1052 without any radially-directed forces acting upon deformable element 1056. The presence of gap 1051 relaxes manufacturing tolerances and thus brings down the cost of manufacturing spray valve 1010.

[0311] Deformable element 1056 may be formed with one or more holes in its central portion or any other portion thereof. The upper end of plunger 1022 preferably abuts against a surface 1059 of deformable element 1056. Alternatively, in the case of plunger 1022 being constructed as a non-hollow needle, plunger 1022 is preferably attached to deformable element 1056, such as by means of spot welding, for example.

[0312] In a most preferred embodiment, deformable element 1056 is constructed of a bimetallic material, i.e., two dissimilar metals welded or otherwise joined together, the two metals having different temperature coefficients of expansion. Due to the different thermal properties of the two metals, deformable element 1056 has a first orientation when in a reference temperature range and reversibly deforms to a second orientation when out of the reference temperature range.

[0313] For example, in the illustrated embodiment, deformable element 1056 is in the first orientation shown in Fig. 40A. In this first orientation, surface 1059 of deformable element 1056 has a generally convex shape when viewed from the upper tip of plunger 1022. Deformable element 1056 applies a force against plunger 1022 generally in the direction of an arrow 1057 so as to prevent plunger 1022 from sliding from the first position of Fig. 40A to the second position of Fig. 40B. In the first position, fluid 1018 can flow from container 1016 into longitudinal bore 1031 of

adapter 1028, but O-ring 1040 substantially prevents fluid 1018 from flowing into counterbore 1044 of guide member 1038. Thus, in the first orientation, deformable element 1056 prevents fluid 1018 from being dispensed through outlet 1020. Deformable element 1056 remains in the first orientation as long as it is in the reference temperature range. For example, as long as deformable element 1056 is below -20°C, it will remain in the first orientation. (As is well known in the art, commercially available bimetallic elements can be supplied for any desired temperature range.)

[0314] If deformable element 1056 is out of the reference temperature range, then deformable element 1056 deforms to the second orientation shown in Fig. 40B. In this second orientation, surface 1059 of deformable element 1056 has a generally concave shape when viewed from the upper tip of plunger 1022. The deformation of deformable element 1056 permits plunger 1022 to slide generally in the direction of an arrow 1055 (opposite to the direction of arrow 1057 shown in Fig. 40A) to the second position shown in Fig. 40B. In the second position, fluid 1018 flows into counterbore 1044 of guide member 1038. In the case of a hollow plunger 1022, fluid 1018 then flows into hole 1046 through plunger 1022 and out of upper hole 1048 into expansion chamber 1014. In the case of a non-hollow plunger 1022, fluid 1018 flows from counterbore 1044 into the space between plunger 1022 and bore 1042 up into expansion chamber 1014. Fluid 1018 then expands in expansion chamber 1014 and exits outlet 1020 as a spray. Deformable element 1056 remains in the second orientation as long as it is out of the reference temperature range. For example, as long as deformable element 1056 is at a temperature equal to or greater than -20°C, it will remain in the second orientation, and fluid 1018 will continue to be dispensed from outlet 1020.

[0315] The temperature of deformable element 1056 is determined by heat transfer between fluid 1018 and deformable element 1056 and by heat transfer between deformable element 1056 and the environment outside of dispenser body 1012, as is now described.

[0316] Operation of spray valve 1010 commences by placing container 1016 with spray valve 1010 attached thereto in an environment whose temperature is out of the reference temperature range. For example, container 1016 is placed in a room whose ambient temperature is greater than -20°C. Heat transfer (by conduction through the walls of dispenser body 1012, and convection and radiation to the room environment)

between deformable element 1056 and the environment eventually brings deformable element 1056 out of the reference temperature range after a period of time. In other words, in the above example, the heat transfer eventually warms deformable element 1056 from a temperature below -20°C to a temperature greater than or equal to -20°C, whereupon deformable element 1056 deforms to the second orientation, plunger 1022 slides to the second position, fluid 1018 flows from container 1016 to expansion chamber 1014 and expands to a fluid spray that exits from fluid outlet 1020, as described hereinabove.

[0317] While plunger 1022 is in the second position, fluid 1018 contacts deformable element 1056 and thereby eventually brings deformable element 1056 back into the reference temperature range. In other words, in the above example, heat transfer between fluid 1018 and deformable element 1056 cools deformable element 1056 from a temperature greater than or equal to -20°C to a temperature below -20°C, such that deformable element 1056 deforms from the second orientation back to the first orientation and plunger 1022 slides back to the first position, thereby preventing fluid 1018 from exiting dispenser body 1012.

[0318] Eventually heat transfer between deformable element 1056 and the environment once again brings deformable element 1056 out of the reference temperature range, and the operating cycle repeats itself.

[0319] Thus spray valve 1010 cyclically dispenses fluid 1018 from container 1016. Various factors affect the frequency and time duration of dispensation, amount of fluid dispensed, the operative reference temperature range, and time for deformable element 1056 to deform between the two orientations. These factors include, *inter alia*:

[0320] a. Size of plunger 1022 and any holes thereof (1046, 1048) through which fluid 1018 flows.

[0321] b. Size of outlet 1020.

[0322] c. Type of bimetallic material (or shape memory alloy, as described below) from which deformable element 1056 is constructed, as well as the size and thickness of deformable element 1056. The type of material affects the time for deformable element 1056 to deform between the two orientations, temperature behavior of deformable element 1056, and force applied against plunger 1022.

[0323] d. Whether fluid 1018 flows on surface 1059 of deformable element 1056 or on an opposite surface thereof (as is described hereinbelow). If fluid 1018 flows on surface 1059, then the fluid pressure of fluid 1018 retards the deformation of deformable element 1056 from the second to the first orientation. Conversely, if fluid 1018 flows on a side opposite to surface 1059, then the fluid pressure of fluid 1018 aids in pushing deformable element 1056 from the second to the first orientation.

[0324] e. The physical and thermal properties of fluid 1018, as well as its pressure.

[0325] f. More than one deformable element 1056 may be used. For example, two or more deformable elements 1056 may be stacked together and used as one composite deformable element. The number of deformable elements 1056 governs the force that the deformable elements apply against plunger 1022. An assortment of deformable elements 1056 may be provided with different thermal characteristics, mechanical properties or physical dimensions, in order to cover a wide range of applications.

[0326] g. Size of expansion chamber 1014.

[0327] h. Thermal properties of thermal insulation 1019.

[0328] It is noted that in the above example, deformable element 1056 is warmed by the environment in order to dispense fluid 1018, and is cooled by fluid 1018 in order to stop dispensing fluid 1018. It is appreciated that the present invention can also be carried out for dispensing fluids which are hotter than the environment. In such a case, deformable element 1056 is cooled by the environment in order to dispense fluid 1018, and is warmed by fluid 1018 in order to stop dispensing fluid 1018.

[0329] An alternative material for constructing deformable element 1056 is a shape memory alloy, such as a nickel titanium alloy. Shape memory alloys have the ability to return to a predetermined shape upon heating via a phase transformation between austenitic and martensitic structures.

[0330] Reference is now made to Figs. 41A and 41B, which illustrate a spray valve 1060 constructed and operative in accordance with another preferred embodiment of the present invention, in respective closed and open configurations. Spray valve 1060 is substantially constructed the same as spray valve 1010, with like elements being designated by like numerals. Spray valve 1060 differs from spray valve 1010 in that

spray valve 1060 includes a channel 1062 which directs flow of fluid 1018 against a surface 1064 of deformable element 1056 opposite surface 1059. Fluid 1018 still exits as a fluid spray from side outlet 1020. As mentioned above, since fluid 1018 flows on surface 1064 opposite to surface 1059, the fluid pressure of fluid 1018 aids in pushing deformable element 1056 from the second to the first orientation.

[0331] Reference is now made to Figs. 42A and 42B, which illustrate a spray valve 1070 constructed and operative in accordance with yet another preferred embodiment of the present invention, in respective closed and open configurations. Spray valve 1070 is substantially constructed the same as spray valve 1060, with like elements being designated by like numerals. Spray valve 1070 differs from spray valve 1060 in that spray valve 1070 includes a channel 1072 which directs flow of fluid 1018 from surface 1064 of deformable element 1056 to an upper outlet 1074, from which fluid 1018 exits as a spray.

[0332] Reference is now made to Figs. 43A and 43B, which illustrate a spray valve 1080 constructed and operative in accordance with yet another preferred embodiment of the present invention, in respective closed and open configurations. Spray valve 1080 is substantially constructed the same as spray valve 1010 or 1060, with like elements being designated by like numerals. Spray valve 1080 differs from spray valve 1010 or 1060 in that in spray valve 1080, deformable element 1056 is arranged with respect to expansion chamber 1014 such that expansion chamber 1014 extends around deformable element 1056 by means of a bypass 1082. In this manner, in the second orientation, fluid 1018 flows against *both* lower and upper surfaces 1059 and 1064 of deformable element 1056. The fluid 1018 can exit from either a side outlet (as shown in Figs. 43A and 43B) or as an upper outlet (as in the embodiment of Figs. 42A and 42B).

[0333] It is noted that aerosol cans contain a pressurized liquid which is dispensed as droplets or as a mist or gas. However, aerosol cans cannot generally dispense a fluid which has already changed to gas inside the can. In the present invention, the presence of expansion chamber 1014 permits dispensing fluid 1018 even if fluid 1018 has already changed to a gaseous state.

[0334] It is be appreciated that many other arrangements of the internal components of spray valves 1010, 1060, 1070 and 1080 are possible within the scope of the present invention.

[0335] Reference is now made to Fig. 44, which illustrates a valve 1090 constructed and operative in accordance with a preferred embodiment of the present invention. Valve 1090 can be employed in any kind of aerosol spray system, including the above described embodiments of the present invention, and is particularly useful in systems which spray a predetermined amount of substance or where a safety valve is required. Valve 1090 can be integrated with or replace the existing valve of the spray system.

[0336] Valve 1090 preferably includes a lower body 1092 with a narrow extension 1094. Extension 1094 is adapted to be fluid connected with a feed tube 1095 through which contents of a container 1096 can flow. Feed tube 1095 is preferably the feed tube shown and described hereinbelow with reference to Figs. 41A-41D, but alternatively any other kind of feed tube may be used. Body 1092 and extension 1094 are preferably formed with a central bore 1098 which extends into a counterbore 1107. In the position shown in Fig. 44, a stopper 1106 is disposed at the bottom of counterbore 1107, thereby defining a volume 1108 between stopper 1106 and an upper end 1102 of counterbore 1107. A clearance preferably exists between the outer perimeter of stopper 1106 and the inner perimeter of counterbore 1107, such that a portion of the contents of container 1096 can flow from container 1096 around stopper 1106 and fill volume 1108.

[0337] An expansion chamber 1099 is preferably formed in an inner volume of an upper body 1110, which preferably has a lower extension 1112 that snaps fixedly on lower body 1092. A soft elastomeric (e.g., rubber) washer 1105 may be placed between upper and lower bodies 1110 and 1092. Alternatively, lower and upper bodies 1092 and 1110 may be constructed as one unitary body, in which case there is no need for washer 1105. Deformable element 1056 is disposed in expansion chamber 1099. A plunger 1100 is preferably attached to deformable element 1056, such as by means of spot welding, for example. Plunger 1100, preferably non-hollow, is arranged to slide from an upper position shown in solid lines in Fig. 44 to a lower position shown in dashed lines.

In the lower position, plunger 1100 preferably sealingly slides into an O-ring 1104 affixed at the upper end 1102 of counterbore 1107.

[0338] In accordance with a preferred embodiment of the present invention, expansion chamber 1099 has a shape that conforms to the limits of the deformed orientations of deformable element 1056. Expansion chamber 1099 preferably is formed with a hole 1099A, through which passes plunger 1100. The conformal shape of expansion chamber 1099 has several advantages:

[0339] a. The shape of expansion chamber 1099 permits placing a spray outlet 1101 at any angle or orientation in expansion chamber 1099, thereby enabling spraying contents of a container in any direction.

[0340] b. Any number of spray outlets 1101 of any combination of size and shape may be employed, through which the contents are sprayed essentially simultaneously. By controlling the number, size and shape of the outlets 1101, one can substantially prevent excess pressure build-up in expansion chamber 1099.

[0341] c. Because of the shape of expansion chamber 1099, the fluid contents of the container flow both over and under deformable element 1056 generally at the same time.

[0342] d. The conformal shape of expansion chamber 1099 has a small volume, thereby permitting spraying small dosages of the contents of the spray container.

[0343] e. The shape also prevents accumulation of any leftover matter that did not completely exit the expansion chamber 1099 during the previous spraying. Any leftover matter flows along the bottom of expansion chamber 1099, drains through hole 1099A and is sprayed during the next spraying.

[0344] f. The size of expansion chamber 1099 determines the quantity of fluid 1103 that can be sprayed, and the amount of liquid droplets of fluid 1103 that will be sprayed as opposed to gaseous matter. The larger the chamber, the more room there is for fluid 1103 to expand, and consequently less liquid droplets will be sprayed. Conversely, the smaller the chamber, the more liquid droplets will be sprayed. The maximum quantity of substance which can be sprayed at a time is about equal to volume 1108. However, it is preferable not to spray more than volume 1108 at a time, so that stopper 1106 will not become lodged in end 1102 of bore 1098.

[0345] Operation of valve 1090 is now described. Initially, a quantity of fluid 1103 has flowed from container 1096 through tube 1095 and bore 1098 into volume 1108. When deformable element 1056 is in the upward (solid line) position of Fig. 44, the internal pressure of the contents of container 1096 push upwards (in the sense of Fig. 44) against stopper 1106 and force some of the fluid 1103 upwards from volume 1108 through hole 1099A into expansion chamber 1099. Fluid 1103 expands in expansion chamber 1099 and exits as a spray through spray outlet or outlets 1101. Fluid 1103 flows around the ends of deformable element 1056, such that fluid 1103 cools both sides of deformable element 1056. Once deformable element 1056 has sufficiently cooled, it snaps to the lower (dashed line) position shown in Fig. 44. Plunger 1100 slides into O-ring 1104 and seals the upper end 1102 of counterbore 1107. Stopper 1106 drops back down by gravity to the bottom of counterbore 1107 and a fresh portion of the contents of container 1096 flows upwards past stopper 1106 and re-fills volume 1108. The re-filled volume 1108 is now ready for the next spray.

[0346] Optionally, valve 1090 may be configured to be a one-way valve, i.e., a valve that prevents matter from flowing back into container 1096. This may be accomplished by placing a small, preferably elastic, ball 1156 below stopper 1106. Ball 1156 can become lodged in a chamfered portion 1158 formed in bore 1098 at the throat of lower extension 1094. Ball 1156 does not interfere with flow of fluid 1103 from container 1096 towards deformable element 1056 and chamber 1099, but does substantially prevent flow of fluid backwards towards container 1096.

[0347] Once again, it is to be emphasized that deformable element 1056 is free to snap from one position to another without any clamping forces. This is because deformable element 1056 is not clamped, but rather freely supported. There is preferably an up-and-down gap 1183 (in the sense of Fig. 44) and a radial gap 1185 between deformable element 1056 and the inner surfaces of expansion chamber 1099. Radial gap 1185 ensures that there are no radially-directed stresses acting upon deformable element 1056, and enables plunger 1100 to self-center relative to O-ring 1104 without any radially-directed forces acting upon deformable element 1056. The presence of gaps 1183 and 1185 relaxes manufacturing tolerances and brings down manufacturing costs.

[0348] Generally only about half or less of the fluid 1103 in volume 1108 is sprayed at a time. Various factors affect the frequency and time duration of dispensation, amount of fluid dispensed, the operative reference temperature range, and time for deformable element 1056 to deform between the two orientations, as described hereinabove.

[0349] If any malfunction occurs and plunger 1100 does not close properly, the internal pressure of the contents of container 1096 will continue to force stopper 1106 upwards towards upper end 1102 of bore 1098 such that stopper 1106 will become lodged in end 1102 of bore 1098, thereby substantially sealing upper end 1102 of bore 1098 and preventing further spraying of the contents. It is noted that in Fig. 44 stopper 1106 is illustrated as having an upper protrusion 1106A which abuts against upper end 1102. However, it is appreciated that stopper 1106 could be flat and still seal against end 1102, because the internal pressure of the contents of container 1096 will maintain an upward force against stopper 1106.

[0350] Thus, stopper 1106 acts as a safety valve which prevents undesirable over spraying of the contents. Stopper 1106 can prevent leaking or overspraying due to a variety of malfunctions. For example, malfunctions can possibly occur due to: knocks or blows to the container 1096, dropping the container, a gas leak, or the fluid inside the container being spent. In all cases stopper 1106 will act as a safety valve because the internal pressure will maintain stopper 1106 sealed against end 1102. In addition, if spraying is performed with the container in a horizontal or inverted position, stopper 1106 will also substantially prevent spraying, because the internal pressure will again maintain stopper 1106 sealed against end 1102.

[0351] In accordance with a preferred embodiment of the present invention, an on-off switch 1177 can be provided next to deformable element 1056. On-off switch 1177 may be simply constructed, for example, as a stem 1178 that slides in a bore 1179 formed in an upper portion of upper body 1110. A pin 1180 preferably protrudes from a side of stem 1178. Stem 1178 can be pushed against deformable element 1056 in the direction of an arrow 1181 in Fig. 44, whereupon stem 1178 can be turned approximately a quarter-turn so that pin 1180 is received in a groove 1182 formed in the upper portion of upper body 1110. Once on-off switch 1177 is pushed against deformable element 1056, deformable element 1056 cannot snap to the upper position

of Fig. 44, and valve 1090 is thus switched off. Conversely, the valve is turned on by removing pin 1180 from groove 1182.

[0352] On-off switch 1177 can act as a manual reset for the stopper 1106 as well. The action of pushing on-off switch 1177 downwards (in the sense of Fig. 44), without quarter-turning stem 1178, dislodges stopper 1106 from the upper end 1102 of counterbore 1107. It is appreciated that other on-off switches may also be employed.

[0353] It is noted that the embodiment of Fig. 44 is distinguished, *inter alia*, by its simple construction - deformable element 1056, lower and upper bodies 1092 and 1110, plunger 1100, expansion chamber 1099, stopper 1106 and O-ring 1104 (and optionally washer 1105, ball 1156 and on-off switch 1177). The contents of the container flow directly to deformable element 1056 without any need for extraneous structure.

[0354] The fluid contents can be directed to flow from underneath deformable element 1056 as shown and described hereinabove with reference to Figs. 40A and 40B, or above deformable element 1056 as shown and described hereinabove with reference to Figs. 41A and 41B. In other words, one can construct valve 1090 such that the flow of the contents helps deformable element 1056 snap back to the closed position (i.e., flow from underneath deformable element 1056). Alternatively, one can construct valve 1090 such that the flow of the contents retards deformable element 1056 from snapping back to the closed position (i.e., flow from above deformable element 1056). As another alternative, deformable element 1056 can be formed with one or more holes through which the contents can be sprayed. The contents can also flow around deformable element 1056.

[0355] In the case of the fluid contents being directed to flow from underneath deformable element 1056, the upward flow of the contents applies an upward force upon plunger 1100. This force aids in snapping deformable element 1056 to the spray orientation, and shortens the time between sprayings. The smaller the cross-sectional area of plunger 1100, the smaller the force of the contents, and the longer time between sprayings. This upward force can cause deformable element 1056 to snap to the spray orientation before deformable element 1056 has actually reached the temperature normally required for snapping (i.e., actuation temperature). This allows using a deformable element with a slightly higher actuation temperature, which generally means

cost savings, because the price of bimetallic discs generally decreases with higher actuation temperatures.

[0356] Reference is now made to Figs. 45A and 45B, which illustrate a spray valve 1180 constructed and operative in accordance with still another preferred embodiment of the present invention. Spray valve 1180 is constructed generally similarly to valve 1090, with like elements being designated by like numerals. Spray valve 1180 employs a generally rectangular deformable element 1182 either freely supported and placed between two halves 1184 and 1186 of an expansion chamber 1188, or alternatively, clamped around its perimeter by the two halves 1184 and 1186, or further alternatively, clamped at only two ends thereof. It is generally the central area of deformable element 1182 which snaps from one position to another.

[0357] A hole is preferably formed in the bottom of half 1186 for plunger 1100 to pass therethrough and for draining any leftover matter from previous sprayings. Deformable element 1182 is preferably formed with one or more generally rectangular apertures 1190, through which matter can be sprayed. The matter can exit expansion chamber 1188 through an upper spray outlet 1192, for example. Valve 1180 operates in the same manner as the other valves of the present invention, described hereinabove. It is appreciated that any abovementioned variations in construction, such as number and position of spray outlets, for example, can be incorporated in valve 1180 as well. Unlike circular bimetallic elements, the rectangular deformable element (bimetallic or shape memory) is not sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement under the influence of all-around clamping.

[0358] Reference is now made to Figs. 45C-45F which illustrate a spray valve 1194 constructed and operative in accordance with yet another preferred embodiment of the present invention. Spray valve 1194 is constructed generally similarly to valve 1180, with like elements being designated by like numerals. Spray valve 1194 employs a generally rectangular deformable element 1196 with short ends 1198 which may be bent. Deformable element 1196 is preferably freely supported in an expansion chamber 1137. There is preferably a gap 1135 between short ends 1198 and an inner surface of expansion chamber 1137.

[0359] In Fig. 45C, deformable element 1196 is bent upwards, in the sense of the figure. As deformable element 1196 starts to snap downwards, the short ends 1198

move outwards in the direction of arrows 1127 and abut against inner surfaces of expansion chamber 1137, as seen in Fig. 45E. Once deformable element 1196 snaps downwards to the position shown in Fig. 45F, there is again a gap 1135 between short ends 1198 and an inner surface of expansion chamber 1137.

[0360] Many aerosol cans contain liquid and gaseous contents which must be shaken before spraying in order to mix these contents properly. Unfortunately, sometimes users forget to shake the contents, and in some spraying systems, it is inconvenient or impossible (such as in automatic spray dispensers) to shake the contents before each spray. The present invention enables spraying such contents without any need for shaking as is now described.

[0361] Reference is now made to Figs. 46A, 46B and 46C which illustrate a tube 1122 useful for spray apparatus, constructed and operative in accordance with a preferred embodiment of the present invention. Tube 1122 preferably has a lower open end 1124 in fluid communication with contents of a spray container 1128. Lower open end 1124 may be at the tip of tube 1122, or alternatively may be on a side wall of tube 1122. Lower open end 1124 may be weighted, if desired, so that open end 1124 gravitates towards the lowest part of container 1128, irrespective of the angle at which container 1128 is positioned.

[0362] Spray container 1128 may be any kind of spray container of the present invention or of the art, and the upper end of tube 1122 may be connected to any kind of spray nozzle (not shown) of the present invention or of the art, including the safety valve of Fig. 44. The contents of container 1128 preferably include a first substance 1126, which generally remains in a fluid (liquid or gaseous) state in container 1128, and a second substance 1117 which preferably comprises a liquid portion 1132 and a gaseous portion 1133. Gaseous portion 1133 maintains a generally constant pressure on liquid portion 1132 and first substance 1126. It is this pressure which pushes the contents of container 1128 out through tube 1122 for spraying, as will be described hereinbelow. In many spraying applications, it is preferable that the first substance 1126 and liquid portion 1132 be mixed prior to being sprayed. Tube 1122 mixes the two substances 1126 and 1117 as is described hereinbelow.

[0363] It is noted that the present invention is also applicable for spraying fine, solid particles as well. Thus, first substance 1126 can also comprise a solid material,

such as a sprayable powder. Second substance 1117 does not necessarily have to include both a liquid portion 1132 and a gaseous portion 1133, but rather can be either liquid alone or gas alone.

[0364] Tube 1122 is preferably formed with one or more side apertures of any size or shape. In the illustrated embodiment, there are three apertures, designated 1130A, 1130B and 1130C, although it is appreciated that any number of apertures may be formed in tube 1122. (Tube 1122 may alternatively or additionally be provided with one or more gas intake apertures 1139 to perform functions described further hereinbelow with reference to Fig. 46D.) Fig. 46A shows spray container 1128 filled with liquid portion 1132 above first substance 1126, and gaseous portion 1133 above liquid portion 1132. It is seen that liquid portion 1132 is in fluid communication with the upper aperture 1130A. When the spray nozzle is opened for spraying, the internal pressure of container 1128, i.e., the downward pressure supplied by gaseous portion 1133, forces the first substance 1126 into the open end 1124. As first substance 1126 rises in tube 1122, liquid portion 1132 can enter the upper aperture 1130A and mix with first substance 1126 as it flows upwards in tube 1122. In this manner, the two substances are mixed prior to being sprayed, without any need for shaking the contents of container 1128.

[0365] In Figs. 46B and 46C, a sufficient amount of the contents have been sprayed such that spray container 1128 is now partially full or nearly empty, respectively. Liquid portion 1132 is now in fluid communication with the middle aperture 1130B or lower aperture 1130C, respectively. Once again, when the spray nozzle is opened for spraying, the downward pressure supplied by gaseous portion 1133 forces first substance 1126 into the open end 1124. As first substance 1126 rises in tube 1122, liquid portion 1132 can enter the middle or lower aperture 1130B or 1130C, respectively, and mix with first substance 1126 as it flows upwards in tube 1122. The two substances are mixed prior to being sprayed, without any need for shaking the contents of container 1128.

[0366] It is noted that in Fig. 46B, gaseous portion 1133 enters the upper aperture 1130A and mixes with first substance 1126 and liquid portion 1132. In Fig. 46C, gaseous portion 1133 enters the upper and middle apertures 1130A and 1130B and mixes with first substance 1126 and liquid portion 1132. In each case, the added

ingredient of gaseous portion 1133 slightly changes the proportion of first substance to the second substance. Although the change in proportion is generally negligible, nevertheless it can be minimized by varying the relative sizes of the lower, middle and upper apertures 1130A, 1130B and 1130C. In general, the amount of gaseous portion 1133 which enters tube 1122 and mixes with first substance 1126 and liquid portion 1132, is mostly a function of the inner diameter of tube 1122 and the sizes of apertures 1130, rather than the number of apertures 1130.

[0367] In summary, it is possible to have small, although for most applications negligible, differences in the ratio of first substance to second substance as the contents are emptied from container 1128. The factors which affect the mixing ratio of first substance 1126 and liquid portion 1132 include, *inter alia*, initial ratio of first to second substance, properties of first and second substances 1126 and 1117, the amount of gaseous portion 1133 left as the contents of container 1128 are emptied, diameter, shape or size of the side apertures 1130 and their relative position to each other, internal pressure of the container, and the spray time, i.e., the amount of time the contents are sprayed.

[0368] Optionally, as shown in Fig. 46D, tube 1122 may have one or more apertures 1139 formed at an upper end thereof which are in fluid communication with gaseous portion 1133 at all times, and are not in fluid communication with first substance 1126 nor liquid portion 1132. In this manner, each time the contents of container 1128 are sprayed, first substance 1126 flows up through tube 1122 and mixes only with gaseous portion 1133, thereby maintaining a constant ratio of the mixture of first substance 1126 and second substance 1117 (in the form of gaseous portion 1133), no matter whether the container 1128 is full or not.

[0369] It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove.